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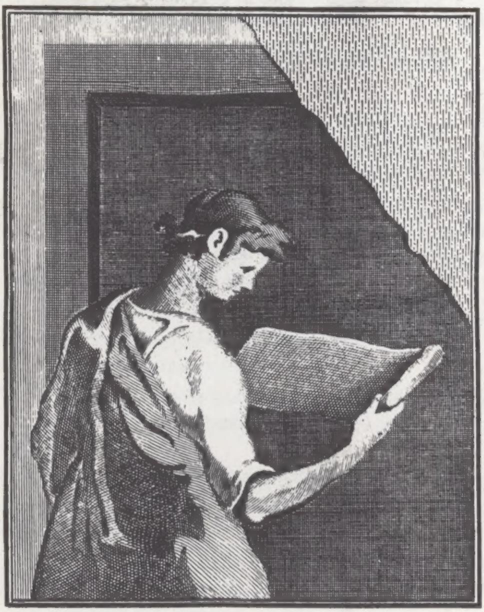

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Ever yours truly
Henry D Rogers.

Engd. for the Annual of Scientific Discovery 1858.

Gould and Lincoln, Boston.

ANNUAL

OF

SCIENTIFIC DISCOVERY:

OR,

YEAR-BOOK OF FACTS IN SCIENCE AND ART

FOR 1858.

EXHIBITING THE

MOST IMPORTANT DISCOVERIES AND IMPROVEMENTS

IN

MECHANICS, USEFUL ARTS, NATURAL PHILOSOPHY, CHEMISTRY, ASTRONOMY, GEOLOGY, ZOOLOGY, BOTANY, MINERALOGY, METEOROLOGY, GEOGRAPHY, ANTIQUITIES, ETC.

TOGETHER WITH

A LIST OF RECENT SCIENTIFIC PUBLICATIONS; A CLASSIFIED LIST OF PATENTS; OBITUARIES OF EMINENT SCIENTIFIC MEN; NOTES ON THE PROGRESS OF SCIENCE DURING THE YEAR 1857, ETC.

EDITED BY

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NOTES BY THE EDITOR

ON THE

PROGRESS OF SCIENCE FOR THE YEAR 1857.

The Eleventh Meeting of the American Association for the Promotion of Science was held at Montreal, commencing August 12th. The president elect, Professor J. W. Bailey, having died during the year, the vice president, Professor Caswell, of Brown University, was the acting President. The number of members in attendance was as large as at any previous meeting. Mr. Ramsay was received as delegate from the Geological Society of London, and Mr. B. Seeman, from the Linnæan Society of London.

The whole number of Papers presented was 109; 40 in the section of Physics and Meteorology; 45 in Geology and Natural History; and 24 in Ethnology, Chemistry, Statistics, etc.

A biographical memoir of Mr. William C. Redfield, the first president of the Association, was read by Professor D. Olmstead, and one of Professor Bailey, by Dr. A. A. Gould of Boston.

The following officers were elected for the ensuing year: — Prof. Jeffries Wyman of Cambridge, President; Prof. J. E. Holbrook of Charleston, S. C., Vice-President; Prof. Chauvenet of Annapolis, General Secretary; Dr. A. S. Elwyn, Treasurer. The invitation of the Maryland Institute and Historical Society, of that State, to the Association to hold its next meeting at Baltimore, was accepted, and the last Wednesday of April, 1858, fixed upon as the commencement of the session.

The Association appointed a Committee, consisting of Messrs. James Wynne of New York City, E. B. Elliott of Boston, and Franklin Hough of Albany, to report a plan for a uniform system of Registration of Births, Deaths, and Marriages, applicable to the United States. This Committee have, since the adjournment of the Association, issued a circular, calling for information and suggestions, in which they say: —

"The necessity for such a measure, to meet the growing demands of science in its application to vital statistics, and the facilities which it would afford in establishing legal evidence in courts of justice, are of too obvious a character to need enforcing by argument. The success with which systems of registration have been employed in Europe, and the gratifying results that have attended their application in some portions of the United States, lead to the hope that the time is not distant when we may have throughout the Union a practical and thorough system, accurate in its details and comparable in its results."

The Twenty-seventh annual meeting of the British Association for the Advancement of Science, was held at Dublin, Ireland, in August, 1857, Dr. Lloyd in the chair. The meeting was one of the most successful in the annals of the Association, and many papers of great value were presented.

The meeting for 1858 was appointed to be held in Leeds. Prof. Owen, being the President elect. The honor was offered to Dr. Whately, Archbishop of Dublin, but he declined it on the ground that his state of health would not allow him to undertake any duties beyond those of his archiepiscopal office. For 1859 a suggestion in favor of Aberdeen was warmly entertained, and it was agreed to invite Prince Albert to be the President for that year.

The following resolutions, affecting the general interests of science, were passed at this meeting of the Association: —

Resolved, That a Committee be appointed to express to the Government the wish of the British Association that self-recording Anemometrical Instruments should be established on some of the islands of the Atlantic Ocean, in aid of the Meteorological Observations now being carried on on ship-board under the direction of the Meteorological department of the Board of Trade.

That application be made to Government to send a vessel to examine and survey the entrance to the Zambesi River in South Africa, and to ascend the river as far as may be practicable for navigation.

That application be made to Government to send a vessel to the vicinity of Mackenzie River, to make a series of magnetic observations with special reference to the determination of the laws now known to rule the magnetic storms.

It having been found that the application of science to the improvement of steam-ships has been impeded by the difficulty of obtaining the necessary data from the present registration, — Resolved, that a Committee be appointed and authorized to communicate, if necessary, with the Board of Trade on the subject.

The Ray Society held its Fourteenth Annual Meeting during the meeting of the British Association at Dublin. Mr. Babington, of Cambridge, was in the chair. The Report stated that the members for

1856, had received Prof. Allman's monograph of the British Fresh-water Polyzoa. Great praise was bestowed by the Council on the author and artist of this work. This year the members are to have for their subscription a work by Prof. Williamson on the British Foraminifera. Prof. Huxley's work on the Oceanic Hydrozoa is promised for 1858–9.

Among the Geographical Expeditions now, or recently in progress, we may mention the following: That of Lieuts. De Crespigny and Forbes of the British Navy, in the interior of Borneo; and that of Major Burton, (the Pilgrim to Mecca,) and Capt. Speke, in Eastern Africa; the latter carry with them a portable iron boat, and hope to reach the Lake Ngassi.

The expedition fitted out in England for the purpose of exploring both branches of the Niger, by the steam propeller Dayspring, in charge of Dr. Baikie, R. N., left the Binue or Kowara river for the Niger, on the tenth of July, and has since been heard from in the far interior. The expedition is composed of fifty Kroomen, twenty-five natives of the countries bordering on the Niger, and fourteen Europeans, including a naturalist, botanist, and engineers. It is the intention to form trading posts on the banks of the river at the most eligible situations for the collection of cotton, shea, outter and other productions of the interior, provided the climate offers no insuperable obstacles.

Another expedition is now exploring the Congo river. It is commanded by Ladislaus Magyar, of the Portuguese army, accompanied by men of science. His orders are to make a full survey of that stream.

A scientific expedition for the exploration of the Colorado river of the West, has been recently sent out by the U. S. Government, under the charge of Lieut. Ives, commandant, and Dr. J. S. Newberry, Geologist.

Sir R. I. Murcheson, in his annual address, for 1856, before the Geographical Society, (G. B.) called attention to a region in British North America, including at least 112,000 square miles, extending from the head waters of the Assiniboine river to the foot of the Rocky Mountains, and from the northern branch of the Saskatchewan to the 49th parallel of latitude, which has remained almost completely unexplored.

Since then, an expedition under the auspices of the British Government, commanded by Mr. Palliser and Lieut. Beakston, R. A. has been sent out to explore the above mentioned territory. The chief objects of the expedition are, First: to survey the water parting between the basins of the Missouri and Saskatchewan; also the course of the south branch of Saskatchewan and its tributaries. Secondly: to explore the Rocky Mountains, for the purpose of ascertaining the mostsoutherly pass across to the Pacific within the British Territory.

Thirdly: To report on the natural features and general capabilities of the country, and to construct a map of the routes.

At the last dates received, July 1857, the party were *en route* to the Saskatchewan river, previous to wintering at Carlton House Fort. The correspondence of Mr. Palliser, communicated to the Geographical Society describes the falls of Kakataka, on the White Fish river as finer in some respects than those of Niagara, being upwards of 171 feet in height. The volume of water, however, is much less.

The London Literary Gazette publishes the following *resumè* of the botanical researches and investigations which have recently been undertaken, or are now in progress under the auspices of the Government of Great Britain: —

1. Mr. Milne, Botanist to the Surveying Voyage of Capt. Denham, in H.M.S. *Herald*, is still pursuing his researches in the South Seas, and especially among the Fejee Islands.

2. Dr. H. Fred. Mueller, the able and indefatigable Government Botanist of Victoria, received the appointment of Botanist to the Overland Expedition in North Australia, under the command of Mr. Gregory. This arduous journey has been happily accomplished in the most satisfactory manner. Dr. Mueller has safely returned with his collections, and some account of them will appear in the "Journal of Botany." His expenses were borne by the Australian government.

3. Vancouver's Island and the adjacent coasts of North-West America. Capt. Richards, R. N., has lately sailed in H.M.S. *Plumper*, for the purpose of surveying these countries, which have attracted no small degree of attention since the boundary line between the United States territories and the British possessions in North America has been so fully discussed, and we believe settled. Although no botanist, or express botanical collector, has been attached to the survey, the assistant-surgeon, Dr. Campbell, and some of the officers, will exert themselves to collect plants; and we know also that a free passage, and every assistance and facility for herborizing on shore, will be offered to a collector, now expected to be at San Francisco, and who has been invited to join the survey. Vancouver's Island, of very great extent, is said to abound in pines and forest trees.

4. Mr. Barter, one of the very intelligent gardeners of the Regent's Park Garden, has been appointed by the Admiralty to accompany Dr. Baikie, R. N., in his present ascent and survey of the Kwóra and Binue (formerly considered the Niger and Tsádda); and from Dr. Baikie's familiarity with that river there is reason to expect that great opportunities will present themselves for increasing our knowledge of this part of tropical Africa, which has been the grave of so many of our scientific explorers.

5. The present of a beautiful steam-yacht, lately sent by the British

Government to the Emperor of Japan, it was thought by the Admiralty might be a means of affording facilities for a botanist to penetrate into that little-known country, and they generously offered a passage to a botanical collector, should the Royal Gardens deem it expedient to send one. Mr. Charles Wilford, of the Botanical Gardens at Kew was therefore appointed, and has entered upon the duties of his office. Mr. W., when his time for remaining in Japan shall have expired, will be attached to H.M.S. *Actæon*, for the survey of the coasts of Northern China, and especially Eastern Tartary (or Mantchouria), a *terra incognita* we believe to the European botanist, and likely to yield a very rich harvest.

6. The sixth and last botanical mission we have to notice, is that which is exploring the south-western territories of the British possessions in North America. The expedition is accompanied by a scientific staff, and the object is to make researches in the little known parts of British North America, especially among the Rocky Mountains and towards the United States boundary line, in about latitude 48°.

Much of this country is only known to the Canadian voyageurs and Indian hunters; but by far the most interesting region will be a new route across the Rocky Mountains, between the United States boundary and the present only practicable route of the voyageurs, in about 55° N. lat. Here the country will be wholly new, and it is hoped the expedition will receive instructions to prosecute their researches as far as the West coast at the Gulf of Georgia, or Straits of De Fuca of the Pacific Ocean.

During the past year a new expedition, fitted out by lady Franklin, and under the charge of an experienced Arctic voyageur, Capt. M'-Clintock, has sailed in search of the lost navigators.

A glance at any recent map of the Arctic regions shows that nearly the whole area east and west of the outlet of the Fish River has been swept by Government searching expeditions. Apart, then, from the fact that Esquimaux reports point to a very limited locality where the great Arctic mystery lies concealed, we are warranted in hoping that a search within an area embracing not more than 370 miles of coast, may be rewarded by the discovery of the Erebus and Terror. Capt. M'Clintock proposes to make his way down Prince Regent's Inlet, and thence through Bellot's Strait to the field of search; or, should the ice permit, to proceed direct to it by going down Peel Sound, which he has good reasons for believing to be a strait. If prevented by the ice from passing through Bellot's Strait, or going down Peel Sound, he will abandon the idea of taking his ship through these channels, and, leaving her in safety in Prince Regent's Inlet, will proceed to search for the Erebus and Terror, by sledging parties. Capt. M'Clintock's primary object will, of course, be the rescue of a single survivor of the

Franklin Expedition, if one should exist, as recent reports brought home by whaling captains would tend to show may possibly be the case. Secondly, the discovery and restoration of any documents or relics appertaining to the lost Expedition; and, thirdly, the verification of the course taken by the Franklin Expedition, and confirmation of the report brought home by Dr. Rae, to the effect that in the early spring of 1850, a party from the Erebus and Terror landed a boat on King William Land,—a fact which in itself establishes the priority of the discovery of a North-West Passage by Sir John Franklin. The locality to be searched is in the immediate vicinity of the North Magnetic Pole, one of the most interesting spots on the face of our globe, which, however, it will be remembered, is not stationary. With the view of taking advantage of the opportunities thus presented for magnetical investigations, the Council of the Royal Society voted a sum of money for the purchase of magnetical and meteorological instruments; and a committee, consisting of distinguished physicists, have supplied Capt. M'Clintock with desiderata in magnetism and meteorology, while Sir W. Hooker and Dr. Hooker have furnished instructions respecting botanical collections, and supplied Ward's cases for the growth of esculent vegetables.

The following is a summary statement of the recent geographical surveys planned or executed under the authority of the Russian Government during the last few years:—

The most important has been the exploration of the Amour River. This vast river, which flows through Chinese Tartary, has not hitherto been surveyed, and is very loosely located on even the best maps. It rises in the mountains of Siberia, east of Lake Baikal, and flows eastwardly through the immense district of Mantchouria into the Sea of Ochotsk, in fifty-three degrees north latitude. Its length is 2,200 miles, being about as large as the Mississippi. An exploration and scientific survey has been made of Lake Baikal, the largest body of fresh water on the Asiatic continent. It is situated in Southern Siberia, between latitude fifty-one degrees and fifty-six degrees north, and between longitude 103 degrees and 109 degrees east. It is about 370 miles in length, forty-five miles average width, about 900 miles circuit — somewhat larger than Lake Erie. Its depth is very remarkable, as it is surrounded by high mountains. The River Angoria, its outlet, joins the Yenisei River, and flows north until it reaches the Arctic Ocean, making, in its total length, another of the great rivers of the world — some 2,600 miles. Through its channel an immense volume of water is emptied into the Bay of Yenisei, and thence into the Sea of Kara, in north latitude seventy-three degrees, east longitude eighty-five degrees, being six degrees thirty minutes within the Arctic circle. Owing to its Arctic outlet it is rendered impracticable commercially, al-

though it is the largest river flowing into the Arctic seas from either continent. A survey of the valley of the Maniteh and of the fisheries of the Caspian Sea has been made by M. Baer. The river Maniteh is 315 miles in length, empties itself into the Don, and so finds its way to the Sea of Azov.

A geographical and scientific survey of the southern portion of Eastern Siberia is now under way, under the supervision of M. Ousoltseff. Geographical detail in relation to this region has hitherto been little more than a blank.

During the past year intelligence has been received of the murder of Dr. Vogel, the successor of Dr. Barth, in his explorations in Central Africa. The most authentic accounts relative to his fate, have been obtained through the English Consul at Khartoum, Upper Nubia, from an envoy of the King of Darfur to the Pacha of Egypt. According to his statement, Dr. Vogel (Abdul Wahed) " had departed from Bornu for Berghami, where he was well received, and after having visited all localities as he wished, he proceeded to Madagu, and from thence passed to Borgu, that is to say, Waday, where he met the Vizier of the Prince of Waday, named Simalek, who treated him well. He afterwards entered the interior of that province to the capital city, called Wara, where the Prince Seiaraf, so called Sultan of Waday, who is now paralytic, resides; but in the neighborhood of Wara there is a sacred mountain, the ascent of which is prohibited to all persons. Abdul Wahed (Dr. Vogel), whether informed of this or not, ascended this sacred mountain, and when the prince learned it he ordered him to be put to death, and so it was."

The recent progress of Astronomical Science is thus sketched by Dr. Lloyd, the last President of the British Association, in his inaugural address.— The career of planetary discovery, which began in the first years of the present century, and was resumed in 1845, has since continued with unabated ardor; and since 1846 not a single year has passed without some one or more additions to the number of the planetoids. The known number of these bodies is now fifty. Their total mass, however, is very small. The diameter of the largest is less than forty miles, while that of the smallest (Atlanta) is little more than four.

These discoveries have been facilitated by star-maps and star-catalogues, the formation of which they have, on the other hand, stimulated. Two very extensive works of this kind are now in progress — The Star-Catalogue, of M. Chacornac, made at the observatory of Marseilles, in course of publication by the French Government; and that of Mr. Cooper, made at his observatory at Markree, in Ireland, which is now being published by the Royal Society. It is a remarkable result of the latter labor, that no fewer than seventy-seven stars, previously catalogued, are now missing. This, no doubt, is to be as-

cribed in part to the errors of former observations; but it seems reasonable to suppose that, to some extent at least, it is the result of changes actually in progress in the Sidereal System. The sudden appearance of a new fixed star in the heavens, its subsequent change of lustre, and its final disappearance, are phenomena which have at all times attracted the attention of astronomers. About twenty such have been observed. Arago has given the history of the most remarkable, and discussed the various hypotheses which have been offered for their explanation. Of these, the most plausible is that which attributes the phenomenon to unequal brightness of the faces of the star which are presented successively to the earth by the star's rotation round its axis. On this hypothesis the appearance should be *periodic*. M. Goldschmidt has recently given support to this explanation, by rendering it probable that the new star of 1609 is the same whose appearance was recorded in the years 393, 798, and 1203. Its period in such case is 405½ years.

The greater part of the celestial phenomena are comprised in the movements of the heavenly bodies and the configuration depending on them; and they are for the most part reducible to the same law of gravity which governs the planetary motions. But there are appearances which indicate the operation of other forces, and which, therefore, demand the attention of the physicist — although, from their nature, they must probably long remain subjects of speculation. Of these, the spiriform nebulæ, discovered by Lord Rosse, indicate changes in the more distant regions of the universe, to which there is nothing entirely analogous in our own system. These appearances are accounted for, by an able anonymous writer, by the action of gravitating forces combined with the effects of a resisting medium — the resistance being supposed to bear a sensible proportion to the gravitating action. The constitution of the central body of our own system presents a nearer and more interesting subject of speculation. Towards the close of the last century many hypotheses were advanced regarding the nature and constitution of the sun, all of which agreed in considering it to be an opaque body, surrounded at some distance by a luminous envelop. But the only certain fact which has been added to science in this department is the proof given by Arago that the light of the sun emanated (not from an incandescent solid, but) from a gaseous atmosphere, the light of incandescent solid bodies being *polarized by refraction*, while the light of the sun, and that emitted by gaseous bodies, is *unpolarized*. According to the observations of Schwabe, which have been continued without intermission for more than thirty years, the magnitude of the solar surface obscured by spots increases and decreases *periodically*, the length of the period being eleven years and forty days. This remarkable fact, and the relation which it appears to

bear to certain phenomena of terrestrial magnetism, have attracted fresh interest to the study of the solar surface; and upon the suggestion of Sir John Herschel, a photoheliographic apparatus has lately been established at Kew, for the purpose of depicting the actual macular state of the sun's surface from time to time. It is well known that Sir William Herschel accounted for the solar spots by currents of an elastic fluid ascending from the body of the sun, and penetrating the exterior luminous envelop. A somewhat different speculation of the same kind has been recently advanced by Mosotti, who has endeavored to connect the Phenomena of the solar spots with those of the *red protuberances* which appear to issue from the body of the sun in a total eclipse, and which so much interested astronomers in the remarkable eclipse of 1842. Next to the sun, our own satellite has always claimed the attention of astronomers, while the comparative smallness of its distance inspired the hope that some knowledge of its physical structure could be attained with the large instrumental means now available. Accordingly, at the Meeting of the Association in 1852, it was proposed that the Earl of Rosse, Dr. Robinson, and Prof. Phillips be requested to draw up a Report on the physical character of the moon's surface, as compared with that of the earth. That the attention of these eminent observers has been directed to the subject, may be inferred from the communication lately made by Prof. Phillips to the Royal Society on the mountain Cassendi, and the surrounding region. But I am not aware that the subject is yet ripe for a Report. I need not remind you that the moon possesses neither sea nor atmosphere of appreciable extent. Still, as a negative, in such case, is relative only to the capabilities of the instruments employed, the search for the indications of a lunar atmosphere has been renewed with fresh augmentation of telescopic power. Of such indications, the most delicate, perhaps, are those afforded by the occultation of a planet by the moon. The occultation of Jupiter, which took place on the 2d of January, 1857, was observed with this reference, and is said to have exhibited no *hesitation*, or change of form or brightness, such as would be produced by the refraction or absorption of an atmosphere. As respects the sea, the mode of examination long since suggested by Sir David Brewster is probably the most effective. If water existed on the moon's surface, the sun's light reflected from it should be completely polarized at a certain elongation of the moon from the sun. No traces of such light have been observed; but I am not aware that the observations have been repeated recently with any of the larger telescopes. It is now well understood that the path of astronomical discovery is obstructed much more by the earth's atmosphere than by the limitation of telescopic powers. Impressed with this conviction, the Association has, for some time past, urged upon Her Majesty's Government

the scientific importance of establishing a large reflector at some elevated station in the Southern Hemisphere. In the mean time, and to gain (as it were,) a sample of the results which might be expected from a more systematic search, Prof. Piazzi Smyth undertook, last summer, the task of transporting a large collection of instruments to a high point on the Peak of Teneriffe. His stations were two in number, at the altitudes above the sea of 8,840 and 10,700 feet respectively; and the astronomical advantages gained may be inferred from the fact, that the heat radiated from the moon, which has been so often sought for in vain in a lower region, was distinctly perceptible, even at the lower of the two stations.

The theory and observations of the Rev. Mr. Jones, U. S. N., respecting the zodiacal light, have been published in full during the past year, in one of the volumes of the report of the U. S. Japan Expedition, and additional confirmatory observations made in 1857 in Quito, S. A., by Mr. Jones were also presented to the American Association. The views of Mr. Jones, while they have received the sanction of many astronomers and physicists, are strongly opposed by others, and some very cogent statements in opposition, founded on long continued observations, have been brought forward by Capt. Wilkes, U. S. N. They do not, moreover, seem to find favor with European astronomers, and Prof. Piazzi Smyth, in a recent paper before the Royal Society, after opposing the theory, as published in his Japan Expedition Report, closes by saying, that he does not think Mr. Jones ever saw the zodiacal light at all.

Father Secchi, the well-known astronomer of Rome, is continuing his researches to determine the rotation of the third satellite of Jupiter; the spots upon it are very visible, but it is not easy to get two observations by which to ascertain the rate of motion in any one evening. He reports a difference in the features of Jupiter from last year. The lowest apparent inferior belt "is a perfect assemblage of clouds, and below this is a very fine line of a yellow color, which appears like a microscopic thread stretched across the planet."

As regards the surface of the moon, on which he has, of late, bestowed much attention, he thinks he may pronounce the nature of such lunar regions as he has explored (at a distance), to be similar to that of volcanic regions on the earth.

A reward of $500, having been offered during the past year, through one of the public newspapers of Boston to any one who could exhibit in the presence and to the satisfaction of certain Professors of the Natural Sciences in Harvard University, any such marvellous phenomena as were commonly reported by Spiritualists as having transpired in the presence, or through the agency of certain persons designated as "mediums," — and the offer having been accepted by the defenders

of the reality of the so-called spiritual manifestations, a somewhat lengthy investigation was entered into. The parties in question embraced four scientific gentlemen from Cambridge, a number of the most celebrated mediums from different sections of the country, and a few observers, friends of both parties. The published award of the Committee was as follows: — " The Committee decide that the party accepting the challenge having failed to produce before them an agent or medium who " communicated a word imparted to the spirits in an adjoining room," " who read a word in English written inside a book or folded sheet of paper," who answered any question " which the superior intelligences must be able to answer," " who tilted a piano without touching it, or caused a chair to move a foot;" and having failed to exhibit to the Committee any phenomenon which, under the widest latitude of interpretation, could be regarded as equivalent to either of these proposed tests, or any phenomenon which required for its production, or in any manner indicated a force which could technically be denominated Spiritual, or which was hitherto unknown to science, or a phenomenon of which the cause was not palpable to the Committee, is, therefore, not entitled to claim the proposed premium of $500.

"It is the opinion of the Committee, derived from observation, that any connection with spiritualistic circles, so called, corrupts the morals and degrades the intellect. They therefore deem it their solemn duty to warn the community against this contaminating influence, which surely tends to lessen the truth of man and the purity of woman."

The defenders of the reality and truth of the " Spiritual phenomena " on the other hand assert that the investigation was conducted unfairly, and in such a way as to prevent any successful issue on their part." As regards the two conclusions, the least that can be said is, that the public is about evenly divided in their judgments. It is much to be regretted that the investigation should have thus resulted, and that the Committee, while charging imposture and delusion should fail to prove it beyond a doubt, or possibility of error.

The Annual Prizes awarded by the French Academy for the past year, were principally as follows: * —

The great prize for mathematical science was given to a German, M. Kummer, for his Researches on complex numbers consisting of roots of unity and of whole numbers. One of the grand prizes in physical science was given to Professor Bronn at Heidelberg, for an extensive work made in reply to the following questions: — 1. What are the laws of distribution of fossil organized bodies in the different sedimentary strata as regards their order of superposition. 2. What as

* Derived from the foreign correspondence of Silliman's Journal.

to their successive or simultaneous appearance or disappearance. 3 What the relations which exist between the present condition of the organic kingdoms and that of earlier time.

Another prize, which had been held out ever since 1847, was given to Lereboullet, Professor of Zoology at Strasbourg. The subject was the following: *To establish, by studying the development of the embryo in two species, taken one from among the Vertebrata, and the other, either from the Mollusca or Articulata, the basis for comparative embryology.* The subject was one requiring long investigation, and the Academy awarded a medal of gold, valued at 3000 francs.

The prize in Experimental Physiology was divided between Messrs. Waller, Davaine and Fabre; the first, for his experiments *on the ganglions of the rachidian nerves;* the second, for his experiments *on the Anguillula Tritici;* the third, for *researches on the action of the poison of the Cerceris (Hymenopterous insects) on the nervous ganglionary system of insects.* This is not the place to analyze the interesting researches of these physiologists. But we may say however that M. Fabre brought out the fact that the larves, with which the insects of the Cerceris family provision their nests for the nourishment of their own young, are struck with a kind of paralysis, which permits of their living for a long time while depriving them of the faculty of feeling or moving. This species of anæsthetic condition is produced by the puncture of one of the thoracic ganglions by the sting of the Cerceris; and M. Fabre has succeeded in producing this condition at will by introducing a little ammonia into the nervous ganglionary system, an effect which he has repeated in other insects.

As usual, the Academy found nothing to compensate or encourage in physics, chemistry, or in mineralogy, if we except a prize of 2500 francs given to M. Schroetter for the discovery of the isomeric state of red phosphorus.

The commission on prizes in medicine distributed upwards of 50,000 francs. The principal recipients were: —

Dr. *Simpson* of Edinburgh, who, as stated by Mr. Flourens, first introduced chloroform into anæsthesis for surgical operations.

Dr. *Middledorp* of Vienna (Austria) for the application of the galvano-caustic in certain surgical operations.

M. Brown-Sequard, for having shown that various lesions of the spinal marrow in the Mammalia, may be followed after some weeks by a convulsive epileptiform affection, produced either spontaneously or by excitation of the ramifications of the fifth pair of nerves on the side corresponding to that of the lesion.

Mr. *Delpeach*, for making known the accidents occuring among workmen in the India-rubber business from the inhalation of sulphuret of carbon.

The Cuvierian prize, which is assigned every three years to the author of works in Natural History, was given to Prof. Richard Owen, who for more than twenty years, through works of great number and elevated character, has contributed largely to comparative anatomy and palæontology. This prize was first given to Prof. Agassiz for his work on fossil fishes, and the second time to Prof. Müller of Berlin, for his researches on the structure and development of Echinoderms.

It is thus seen that in this year, as in others preceding, *foreign* men of science have taken a large part of the prizes, a fact highly honorable to the Academy of Sciences, showing that a right to its munificence does not rest in being a Frenchman, but in being worthy of it through actual labors.

The number of well-endowed Meteorological Observatories is gradually increasing. The Pope has recently authorized the formation of one at Rome, and has contributed liberally towards the expense of constructing it and of providing it with the necessary instruments. The Captain General of Cuba, has also decreed that one shall be established on that island, under the direction of Mr. Poey, the well-known meteorologist.

The Paris Observatory now receives meteorological observations every day from fourteen stations in France and seven in foreign countries. The foreign stations are Madrid, Rome, Turin, Geneva, Brussels, Vienna, and Lisbon. Now that telegraphic communication has been established between France and Algeria, meteorological observations from districts of Northern Africa will also be included.

The sum of $15,000 has been donated to Iowa College by Mr. Chas. Hendrie, for the ultimate purpose of establishing and endowing a school in that institute, similar to the "Lawrence Scientific School in Harvard University."

The French Government has recently created a new chair in the Museum of Natural History, at Paris, under the name of "Vegetable Physics," and has appointed to it M. G. Ville, who has distinguished himself by his researches on the absorption of nitrogen by plants.

The new professor will have, it appears, specially to occupy himself with such matters relative to vegetable production as do not fall strictly within the domain of botany, the cultivation of the soil, and agricultural chemistry.

In an election for a vacant Professorship of the Natural Sciences in the University of Glasgow, Scotland, during the past year, Prof. Henry D. Rogers, Geologist to the State of Pennsylvania, was unanimously chosen. Prof. R. is now engaged in the supervision of the publication of the Report of the Geological Survey of Pennsylvania, which constitutes one of the most important and elegant contributions ever made to natural science.

The sum of two thousand five hundred dollars was appropriated at the last session of Congress "to enable the Secretary of the Treasury to cause such experiments and analyses of different beds of ore as to test whether any such ores, in their native state, possess alloys that will resist the tendency to oxydize to a greater extent than others, and to ascertain under what circumstances they are found, and where, in order to facilitate the proper selections of iron for public works." To carry out the object in view, the Secretary states in his recent Report "that he has caused circulars to be sent to all iron-masters whose names could be ascertained, soliciting specimens of ore and iron, and calling for information pertinent to the subject, and that in compliance with the request, a large number of specimens have been received.

" So soon as the specimens are all received and arranged, and the information which accompanies them has been abstracted and collated, a competent chemist or metallurgist will be employed to make the experiments and analysis. Conclusive evidence has already been received that a decided difference in the susceptibility of different irons to oxydize does exist, and it is hoped that the proposed analysis will discover the cause. However, should the experiments fail in this respect, they will at least show the localities from which the least oxydizable iron can be procured."

The late M. Michaux, the distinguished botanist, author of the Sylva Americana, bequeathed by will, to the Massachusetts Agricultural Society, $8,000, for the purpose of promoting Sylvaculture and Horticulture, and of making experiments in the growth of trees in "sandy rocks and bog soils. The principal portion of the bequest is to be invested for increase in good farm land; cheap and productive land is to be purchased with another portion, and the remainder to be appropriated to seeding and planting the experimental plantations.

A larger sum than the above was also bequeathed the Philadelphia Academy of Natural Science, for similar purposes.

In accordance with a joint resolution of Congress passed in 1857, to provide for ascertaining the relative value of the coinage of the United States and Great Britain, and fixing the relative value of the coins of the two countries, Prof. Alexander, of Baltimore, has been appointed Commissioner to confer with the proper functionaries in Great Britain in relation to some plan or plans of so mutually arranging, on the decimal basis, the coinage of the two countries, as that the respective units shall hereafter be easily and exactly commensurable.

The researches of M. Ville, of France, on the absorption of the nitrogen of the atmosphere by plants during vegetation still continue. The importance of these researches may be best understood by the fact that the French Academy has voted a sum of 4000 francs, the half as an indemnification for the expense of his past experiments, and

the other 2000 francs for continuing his labors. The subject is still in much obscurity, and the issue of further experiments must be awaited. M. Liebig holds that the azote of plants is entirely derived from ammonia, and that there is no direct absorption of the azote of the atmosphere, against which opinion some of M. Ville's researches seem to militate.

The Institute of British Architects announce, as subjects for future prizes; "The Application of Wrought Iron to Structural Purposes;" "The Influence of Local Materials on English Architecture;" and they promise a tangible honor "for the best design in not less than five drawings, for a marine sanitarium, or building for the temporary residence of a limited number of convalescents belonging to the middle and upper classes of society."

M. Milne Edwards, of Paris, has completed the first volume of his great work, "Leçons sur la Physiologie et l' Anatomie Caparée de l'Homme et des Animaux." It is a full exposition of the state of these sciences at the present time, and of the progress they have made since Cuvier wrote on them.

Prof. Harvey, the English Algologist, has now in press, as the result of his Australian expedition, an illustrated marine botany of Australia. The work will contain colored illustrations, and descriptions of three hundred of the more characteristic and remarkable species. This number will allow for the full illustration of all the Genera, and of the principal sub-types composed within each Genus.

The first part of the second volume of the Annals of the Observatory of Harvard College published during the past year, relates wholly to Saturn, and contains the observations made at the observatory by Wm. C. Bond, Director of the Observatory. The general results have been before the public for some time, and their high merit is well known. The observations are brought down to May of the present year. The series of plates contain 120 figures representing the appearances of Saturn and the ring at as many different times of observation.

The celebrated Mezzofanti library has been purchased by the Pope, principally out of his own privy purse, and munificently presented to the Bologna public library. The collection consists of several thousand volumes, principally classical and oriental works, and contains grammars, dictionaries, and educational books alone, in eighty different languages and dialects. The Bologna library, which has had the good fortune to acquire this treasure, possesses already about one hundred and forty thousand volumes, many of which are very rare.

A continuation of Ehrenberg's great work has been recently issued, consisting of eighty-eight pages large folio: and it relates exclusively to North America. It consists of descriptions of earths and river sediments, from different sections of the country, as regards their infu-

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sorial contents, and tables of the results for each. The parcels examined and here described amount to two hundred and forty-seven, eighty-five of which are from Texas, four from Arkansas, thirty-six from the Washita and Neosho, etc. The number of microscopic species observed by Ehrenberg and Bailey in the Southern United States is eight hundred and fifty-five; of these one hundred and forty-eight are brackish water and marine species, about half of them being fossil and half living.

An interesting contribution to our knowledge of Organic Morphology has been made during the past year by Mr. John Warner, of Pottsville, Pa. This name is used to designate that branch of science which seeks to explain organic forms upon mathematical or mechanical principles. The subject has attracted much attention in Europe, but has received but little notice in this country. Mr. Warner's contribution consists of a pamphlet, illustrated by nearly two hundred engravings, containing an account of the labors of foreign Physicists in this field, besides some original formulæ for the construction of curved lines, accompanied with the figures of the curves themselves, and of the organic forms which they resemble.

It is worthy of notice that the author has succeeded in bringing the curves representing, at least approximately, the types of first, the egg, and then of several organic forms, under one general equation, the relation of which to the revolving orbit of Newton, and to the curves of Grandus, is also shown. This, we believe, is a new result. The Curves of Grandus had long been forgotten or neglected; Mr. Warner is, we believe, the first to notice them in connection with Morphological history, as also to introduce some other historical matter gleaned in the field of Mathematics. As the author declines to speculate on the manner in which the vital forces may cause matter to assume the forms represented by his curves, we shall not undertake to supply what may be needed in this respect. We would say, however, that the subject promises to continue to engage the attention of Physicists, and we incline to the belief, which the author appears to entertain, that Organic Morphology will one day become a strict science.

The third volume of Observations made at the Magnetical and Meteorological Observatory at Toronto, Canada, under the general superintendence of Gen. Sabine, R. A., has been published during the past year by the British Government.

The main body of the work is occupied by a record of the observations; but Gen. Sabine has appended to the apparently dry figures a chapter entitled Comments and Conclusions, which contains many interesting remarks and curious deductions. It has been found that in the north-solstitial months, easterly disturbances preponderate, and in the south-solstitial months westerly predominate. The equinoctial

months are the epochs of maximum disturbance, and the solstitial months epochs of minimum disturbance. It has also been discovered that the occurrence of the larger disturbances of the vertical force at Toronto is governed by periodical laws depending on the hours of solar time. The aggregate value of the disturbances in the five years is a maximum at 3 P. M. and a minimum at 11 A. M. There is also a secondary maximum at 5 P. M. and a secondary minimum at 9 P. M.

The three magnetic elements concur in showing that the moon exercises a sensible magnetic influence at the surface of the earth, producing in every lunar day a variation in each of the three elements; but by far the most interesting discovery connected with terrestrial magnetism is the curious accordance between intense magnetic disturbance and spots on the sun. These spots have been observed to increase and decrease in number and intensity decennially, and it appears that the periodical magnetical inequality has its opposite phases of maximum and minimum separated by an interval of five years, of which the cycle might therefore be conceived to include about ten of our solar years. Respecting this remarkable circumstance, General Sabine observes:

"Had no other circumstance presented itself to give additional interest to an investigation which held out at least a fair promise of making known laws of definite order and sequence in phenomena which have excited so much attention of late years, but of which so little has hitherto been ascertained,—had, for example, the decennial period which appeared to prevail with precisely corresponding features in two distinct classes of the magnetic variations, connected itself with no other periodical variation either of a terrestrial or cosmical nature with which we are acquainted,—there might have been, indeed, little reason to apprehend, in these days of physical curiosity and inductive application, that the investigation would have been suffered to drop; but the interest has doubtless been greatly enhanced by the remarkable coincidence, between the above-described periodical inequality by which the magnetic variations referable to solar influence are affected, and the periodical inequality which has been discovered by M. Schwabe to exist in the frequency and magnitude of the solar spots. The coincidence as far as we are yet able to discover, is absolute; the duration of the period is the same, and the epochs of maximum and minimum fall in both cases on the same years. The regularity with which the alternations of increase and decrease have been traced by M. Schwabe in his observations of the solar spots (which have been now continued for about thirty years), must be regarded as conferring a very high degree of probability on the systematic character of causes which as yet are known to us only by the visible appearances which they produce on the sun's disk, and by the disturbances which they oc-

casion in the magnetic direction and force at the surface of our globe. As a discovery which promises to raise terrestrial magnetism to the dignity of a cosmical science, we may feel confident that, although the colonial observatories have been brought to a close, the investigations, which they have thus successfully commenced, will be pursued to their proper accomplishment in those national establishments which have a permanency suitable for such undertakings."

It is evident that the former supposed analogy between magnetical and atmospherical disturbance must now be abandoned, and that we must seek in more distant sources than those of meteorological phenomena for the causes of magnetical disturbances. It can only be, however, by the aid of long-continued and patient observations that the philosopher will be enabled to deduce magnetical laws which it is not too much to assert will be found among the most interesting in the whole range of physical science. For, as Bacon remarks, "Physical knowledge daily grows up and new actions of nature are disclosed," —and it is quite certain that it is the duty of all civilized nations to take an active part in extending physical science, which enters largely into a country's glory and prosperity.

We present to our readers for the present year, the portrait of Prof. Henry D. Rogers, LL. D., Professor of Natural Sciences in the University of Glasgow, Scotland, and Geologist to the State of Pennsylvania.

THE

ANNUAL OF SCIENTIFIC DISCOVERY.

MECHANICS AND USEFUL ARTS.

THE UNION BETWEEN SCIENCE AND COMMERCE.

It is one of the characteristics of the present age that commercial associations of private persons, receiving from the State no assistance except a sanction of their union, and employing their funds only in the ordinary modes of commerce, have been able to execute works which scarcely any power of the State could attempt, and incidentally to give to objects not contemplated in their original enterprise, an amount of assistance which no direct action of the State could give. The latter advantage has been experienced in numerous instances, affecting our social comforts and our constructive arts: it is now felt with equal force in our more abstract science. The history of a late astronomical investigation will illustrate this remark.

The celebrity of the observations of Greenwich and Paris, and the close connection between the subjects of their observations, made it desirable long since, to determine their difference of longitude. About the year 1787 the matter was on both sides taken up by the national authorities, and an expensive and accurate survey was undertaken, — the English part at the expense of the British Government, and the French part at that of the French Government — for connecting the two observatories. This geodetic connection of observatories was the first and ostensible object of the survey, though it led, ultimately, in England, to the construction of ordnance maps. The difference of longitude ascertained by this expensive process was, no doubt, free from any large error; yet men of science were so little satisfied with it that it was thought desirable to take the earliest opportunity of verifying the result by an operation of a different kind.

In the year 1825 another attempt was made also at the expense of the State. On the English side it was managed principally by Mr., now Sir

John Herschel, and Captain, now General Sabine; on the French side, by Colonel Bonne, and some of the most distinguished French engineer officers. The plan adopted on this occasion, was to make simultaneous observations on rocket-signals at a chain of stations extending from Greenwich to Paris. In spite of all the care which had been taken in preparatory arrangements, this enterprise, in a great measure, failed. On the English side, almost every part was successful; but, on the French side, nearly the whole labor was lost, and the final result for difference of longitude depended only on the observation of ten rocket-signals.

Passing over the attempts made to verify the ancient survey, as well as those made by private persons, to determine the difference of longitude by the transmission of a few chronometers, we now come to the more fortunate enterprise which has suggested the preceding-remarks.

No sooner did there appear to be a reasonable prospect of success for the submarine telegraph, than the astronomical authorities (the Astronomer Royal, on the British side, and the Bureau des Longitudes, on the French side) addressed themselves to the Submarine Telegraph Company, with a view of establishing a connection by galvanic telegraph between the two observatories. By that company their applications were received in the most liberal manner. The company's wires were placed at the service of the observatories at the hours most convenient for them; the connections — when necessary — were made by the company's officers, and no remuneration of any kind was expected.

It is not necessary here to go into details upon the method employed, or the extent to which it was carried. It will suffice to say that several thousand signals were interchanged; so many, in fact, as to permit of the rejection of the larger portion, retaining only those — to the number of nearly two thousand — which were considered to be made under unexceptionable circumstances. The contrast of this number with that of the signals on which the determination of 1835 depended, is striking. But the difference in the quality of the individual signals is not less striking. The result of a single signal, given by the galvanic telegraph, is perhaps as accurate as the mean of all the results of the former operation. It is unnecessary, therefore, to say that no comparison can be made between the difference of longitude concluded from the former observations, and that found from the mass of the late signals. The former determination is now shown to be erroneous by almost a second of time — a large quantity in astronomy — and this correction is nearly certain to its hundredth part. For this gain of accuracy, this veritable advance of science, we are indebted, in the first instance, to the power of commercial association of which we have spoken.

The power, however, would have availed little if the possessors of it had not been willing to allow it to be used for the benefit of society in the precise way which the professional men indicated; and it is most honorable to our great commercial bodies that they have practically shown so much readiness to aid in enterprises of scientific character, that accredited men of science feel no difficulty in asking their assistance.

We may congratulate the world on the growing tendency towards a closer

union between science and commerce. The advantages to science in such instances as that which has formed the special subject of our comments, needs no further explanation. The advantages to commercial bodies, though less obvious, are equally certain. It is no small matter that these associations are enabled, without any offensive intrusion, to acquire the character of patrons of science; that the world is ready to acknowledge itself their debtor for assistance not promised in their original constitution. The exhibition of beneficial power without any prospect of immediate pecuniary advantage, removes the mercenary element which might seem to be ingrafted in their original formation, and commerce thus acquires dignity from its friendly union with science. — *Communicated by Prof. Airy, Astronomer Royal to the London Times.*

THE MILITARY RESOURCES OF FRANCE EMPLOYED IN THE RUSSIAN WAR.

A French official document, of unusual interest, has recently been published by Marshal Vaillant, the minister of war, giving a detailed account of all the supplies furnished by France, in men and materials, for carrying on the late war on the part of that nation with Russia. The following is the substance of the facts presented, divested as much as possible, of abstract numerical statements. The results furnish a most striking illustration of the increased efficiency and power which a modern military force derives, through its appropriation of the various improved processes which have been primarily developed for the benefit of commerce and the industrial arts.

The French draw a very useful line between the *personel* and the *materiel* of an army, — words which succinctly denote the men who are to serve, and the supplies which render the service possible. We have no equally convenient terms in English. The statistics of the report in question, are divided into four departments, — the *Personel, Materiel, Accessories* and *Transport.*

Personel. — France sent over, to engage in the war against Russia, 309,268 soldiers, and 41,974 horses, of which numbers about one sixth embarked from Algeria, and the rest from France. Of these, about 70,000 were killed, died, or returned missing on various accounts. There were 146,000 French soldiers in and near the Crimea on the day when the treaty of peace was signed. Of the horses, 9,000 returned to France, and the greater part of the balance were sold to the Turkish government.

In three months, the large French army entirely left the Crimea, although double that time was allowed by the terms of the Treaty of Peace.

Materiel. — The munitions and supplies for two years and a half of service for such an army, at such a distance, were necessarily vast — comprising, as they did, battle and siege weapons of all kinds; the food, forage, clothing, tents, and harness for horses and men; the tools and implements required for encamping, rather than for fighting; and the ambulances, medicines, and other requirements for the sick and the wounded.

The great guns, howitzers, and mortars, were not less than 644 in number; besides 603 contributed by the marine, and 140 Turkish, of various

kinds. There were more thon 800 gun-carriages, and nearly as many ammunition wagons and vehicles of other kinds pertaining to artillery operations. All this was for the siege-works alone; the lighter artillery for field-service presented a further store of guns, carriages, and vehicles, making the vast total of about 1,700 pieces of cannon, and 4,800 wheel-vehicles required for their service, sent from France during the war. As may be readily supposed, the missiles to be vomited forth by these instruments of destruction were numbered by millions rather than by thousands, Their array was fearfully vast: 2,000,000 of cannon balls, shells and similar projectiles; 10,000,000 pounds of gunpowder, in barrels; and 66,000,000 ball-cartridges for muskets and rifles. If Sebastopol had not fallen when it did, France was prepared to plant against it no fewer than 400 mortars of large calibre, besides all the other siege-ordnance, each furnished with 1,000 rounds of shell, sufficient for a continuous bombardment during twenty days and nights, at the rate of fourteen bomb-shells per minute. The siege-works outside Sebastopol, led to the construction, sooner or later, of more than one hundred batteries. Marshal Vaillant estimates the whole weight of the artillery, guns and ammunition, and all the appliances, at 50,000,000 kilogrammes — about 50,000 tons English — all carried over sea from France to the Crimea.

But the engineering materials — the *materiel du genie* — were over and above all those hitherto mentioned. The sappers, miners, engineers, all who were employed in trench duty, mechanical labor, and the like, had implements and materials in immense variety and number. Picks, shovels, boring-tools, sand-bags, palisades, chevaux-de-frise, ventilators, smoke-balls, mills, capstans, ladders, carriages, chests, wheels, planks, iron bars, nails, pitch, tar, candles, charcoal, canvas, mining-powder, tents, wooden huts — all these gave a total in weight of 14,000,000 kilogrammes, — 14,000 tons. Among the largest items were 920,000 sand-bags, and 3,000 wooden huts or barracks. The marshal states that the materiel du genie was five times as great as would have been required, with the same strength of army, for a siege conducted under ordinary circumstances; so exceptional and remarkable was everything connected with the attack on Sebastopol, especially the wintering on a bleak barren plateau. The engineers, during the siege, constructed fifty miles of trench, in which they used 60,000 facines or bundles of fagots, 80,000 gabions or baskets for earth, and nearly 1,000,000 bags filled with earth; besides ten miles of "lines," or defence-works, on the margin of the siege-camp, to prevent the besiegers from being themselves besieged. These "lines" were not mere heaps of earth hastily thrown up: they were deep trenches, excavated mostly in solid rock, breasted by thi[ck] and high parapets, and defended at intervals by strong redoubts. Besides all this, the French and the Russians, during their antagonistic operations of mining and counter-mining, formed no less than five miles of subterraneous galleries or passages in the solid rock, in some places as much as fifty feet below the surface of the ground.

Those readers who may feel bewildered at these vast military operations, will have less difficulty in appreciating the necessity for enormous supplies

of food for the soldiers; but even here, the real quantities almost transcend one's power of belief. The food sent out to the French army included, among many smaller items, about 30,000,000 pounds* of biscuit, 50,000,000 pounds of flour, 7,000,000 pounds of preserved beef, 14,000,000 pounds of salt meat and lard, 8,000,000 pounds of rice, 4,500,000 pounds of coffee, and 6,000,000 pounds of sugar; these, with 10,000 head of live cattle, and 2,500,000 gallons of wine, were the main supplies for provisioning the troops. Nearly 1,000,000 pounds of Chollet's compressed vegetables were among the smaller but most welcome items. Nearly all the preserved meat, in canisters, was purchased of English and Scotch firms; and the war having ended before the vast supply was consumed, the remainder has lately been sold by auction in London, by order of the French government. The collateral manufactures and outlay to which the shipment of these stupendous quantities of food necessarily led, were in themselves remarkable; for instance, no less than 260,000 chests and barrels were required to contain the biscuits alone, and 1,000,000 sacks and bags for other articles. The horse-food, simple in kind, presented a few large items: such as, 170,000,000 pounds of hay, and 180,000,000 pounds of oats and barley. 4,000,000 pounds of wood for fuel, 40,000,000 pounds of coal, charcoal, and coke, 150 ovens to bake the food, 140 presses to compress the hay. These help to make up the enormous total of 500,000 tons weight sent out, relating to food, fodder, and fuel; requiring 1,800 voyages of ships to convey them to the east

The clothing — another great department of materiel — comprised garments in such hundreds of thousands as it would be wearisome to enumerate. It may afford, however, a clue to the matter to state that the number of each of the chief items generally ranges from 200,000 to 350,000. Some of the items are quite French; such as 240,000 pairs of sabots, or wooden shoes, superadded to the 360,000 pairs of leather shoes and boots. The piercing cold of the Crimean winter is brought again into remembrance by such entries as 15,000 sheepskin paletots, 250,000 pairs of sheepskin and Bulgarian gaiters, and 250,000 capotes and hoods. The materials for camps and tents, — almost as necessary to the soldiers as clothing, — were, of course, vast in variety and quantity. There were tents sufficient to accommodate 280,000 men; those made and used in the first instance were shaped somewhat like the roof of a house, with two upright supports, one at each end; but after the dreadful hurricane on November 14, 1854, the French adopted the Turkish form of tent — conical, with one central support — as being better fitted to resist a violent wind. The harness and farriery department presented, as the most curious items, 800,000 horse-shoes, and 6,000,000 horse-shoe nails. Altogether, about 20,000 tons weight of men's clothing, horse clothing, and tent apparatus was sent out.

Accessories. — The artillery supplies, the engineering supplies, the food, fodder, fuel, clothing, harness, and camp apparatus, although furnishing the

* In giving equivalents for French measures and weights, we have estimated the *metre* at about forty inches, and the *kilogramme* at 21-5th pounds, English.

great bulk of the material, yet leave many other departments unnoticed, which we may call accessories, — such as medical service, the treasury, the post-office, the printing-office, and the telegraph.

In no department did the French excel the English so much as in hospital arrangements; at least during the first half of the war-period. If it had not been for Miss Nightingale, and a few other brave hearts, the deaths, through want of the commonest medicines and necessaries, in the English camp and hospitals, would have been much more numerous than they were. The French sent over 27,000 bedsteads for invalids, about the same number of mattresses, and 40,000 coverlets. There were also thirty complete sets of furniture and appliances of every kind, for movable hospitals of 500 invalids each. There were materials for ambulances for 24,000 sick men, 600 cases of surgical instruments, and no less than 700,000 pounds weight of lint, bandages, and dressings of various kinds. Then, for the sustenance of the sick and wounded, there were such medical comforts as concentrated milk, essence of *bouillon*, granulated gluten. Chollet's conserves, etc., to the amount of 200,000 pounds.

The military train, or *equipages militaires*, were the carriers of the army, so long as that army was on Turkish or Russian ground. The number of vehicles required for this service was enormous, the tilted wagons, wagons without tilts, Maltese carriages, Marseille charrettes, and Turkish arabas and tekis, provided for the use of the French military train, were 2,900 in number. There were 900 large chests, to contain about 1,400 soldiers' daily rations each. Altogether, there were 14,000 men and 20,000 horses, mules, oxen, and buffaloes, engaged in carrying food and baggage to the troops.

The treasury, the military-chest — an important adjunct to any army — was well attended to in the French army of the Crimea, by a staff of officers comprising about ninety persons, who managed the post-office as well as the funds. Marshal Vaillant asserts that the French soldiers received their pay and their letters with as much correctness and punctuality outside Sebastopol, as if they had been garrisoned in France. The money was sent over, partly in cash, and partly in treasury notes, which were readily taken by the larger traders in the east. The money thus expended at the seat of war, amounted to 285,000,000 francs, or £11,000,000; this was irrespective of the sums, of course many times larger in amount, expended in France on matters pertaining to the war.

Electro-telegraphy and printing are novel items in the operations of the battle-field. They indicate two among many changes which are coming over the art of war. Both semaphores and electric-telegraphs were provided to communicate orders from head-quarters to the various army-corps encamped outside Sebastopol; and a staff of about sixty persons was told off for this service. The semaphores were wooden telegraphs, which could be set up or removed at a short notice. Besides this, England having laid down a submarine telegraphic-cable from Balaklava to Varna, France undertook to connect that cable with the net-work of European telegraphs, by a line from Varna into the Danubian Principalities, nearly two hundred miles in length; and, a staff of forty persons, stationed at Varna, Shumla,

Rustchuk, and Bucharest, managed this line. As to printing, a lithographic press, at head-quarters, sufficed at first for the wants of the service; but when the siege commenced, General Canrobert found it necessary to issue two or more copies of so many orders, that he procured a complete typographic apparatus from Paris.

Transport. — Lastly, Marshal Vaillant tells us of the vast maritime preparations — not for fighting the Russians — but for conveying French armies over the sea, that *they* might fight the Russians.

The French imperial navy lent 132 ships to the army for this service; and these ships made 905 voyages, carrying — either going or returning — 270,000 men, 4,300 horses, and 116,000 tons of material. Besides this, the English Admiralty lent eight ships-of-war and forty-two chartered vessels to France, to aid in carrying the enormous military burden. But far larger in number were the merchant-ships directly *nolise*, or chartered by the French government, amounting to 1264 of all kinds. A fine fleet of sixty-six steamers and twenty-two fast clippers was constantly making to-and-fro voyages during the war; and in addition to these, there were vessels employed in carrying food and fodder from various parts in Turkey and Asia Minor to the Crimea. Taken in its totality, including all the voyages made by all the men, horses, and materials, there were conveyed by the French government, during a period of two years and a half, 550,000 men, 50,000 horses, and 720,000 tons of materiel.

The marshal adds: "The personnel and the materiel embarked at Marseille were brought to that port, in the larger proportion, by the line of railway stretching from Paris towards the Mediterranean. If that iron road had not existed, the operations of the war would have certainly lost much of their *ensemble* and their rapidity."

Here closes our brief notice of this remarkable document, which, it will be seen, relates wholly to that part of the warlike proceedings in which the French Minister of War was concerned, excluding all that came under the Minister of Marine.

RECENT FRENCH INVENTIONS OF IMPORTANCE.

The following prizes were awarded last year by the French Société d'Encouragement pour l'Industrie Nationale for inventions and improvements in manufactures:

Gold medals were awarded: To M. J. Dubosc for having executed the first portable stereoscope, thus rendering the use of that instrument extremely easy. Stereoscopes are now sold in France to the amount of several millions of francs. To M. Guérin, the inventor of a system of self-acting brakes for railway trains. When the stoker has shut off the steam, and taken the usual precautions for stopping the train, the effect is, that the nearer the carriages are to the tender, the closer they approach each other, so that, while the last and forelast vehicles of the train are still apart, the buffers of the first and second have already met, and their shafts are driven further in than those of the third, fourth, etc. This circumstance has been

turned to account by M. Guérin, for the buffers act upon his brake while they are being driven in, and the brake resumes its former position as soon as the train has stopped, in consequence of the gradual action of the springs of the buffers. These brakes are now extensively used on the Orleans Railway. To M. I. Pierre, Professor of Chemistry at Caen, for his researches into the efficacy of marine manures. To M. Fritz-Sollier, a manufacturer of India-rubber articles, for having re-discovered a method — previously found, but neglected, by M.M. Sace and Jonas in 1846 — for transforming linseed oil into a substance resembling caoutchouc, by treating it with nitric acid. This new compound is now applied for making water-proof stuffs, saddlery, etc. To M.M. Gérard and Aubert for a process by which caoutchouc may, without undergoing a previous dissolution, be rolled out into thin leaves, threads, or pipes. They also are the inventors of the alkalization of that substance, a process which renders it less brittle and much stronger than vulcanized caoutchouc. To M.M. Perreaux and Clair; to the former for his India-rubber valves, and other improvements in instrument making; and to the latter for a new kind of dynamometer. Medals of platinum were given to M. Derrien, for his manufacture of artificial manure of invariable fertilizing power; and to M. E. Muller, for a work on agricultural and workmen's habitations. Silver medals were awarded to Mr. Stanley, for the manufacture of articles in basalt and lava: to M. Dumesnil, for an improved plaster-kiln; to M. Gaudonnet, for improvements in pianofortes; to M. Tripon, for a process of aquatint washing on stone, imitating Indian ink drawings; to M.M. Carmoy and Colas, for gilt nails and a machine for making them; to Dr. Benet, for a contrivance for washing foul linen by pressure; to Dr. Guyot, for a loom for weaving at a very trifling cost straw mats, for gardening purposes; and to M. Klein, for a plan for retailing good and nutritious food to the poor in portions of the value of five centimes each. Bronze medals were awarded: to M. de Luca, for an improvement in blowing pipes, producing an uninterrupted stream of air by means of a hollow ball of India-rubber, acting as a reservoir; to M. Troccon, for an improvement in the lamps called moderators; to M.M. Lacassagne and Thiers, for a regulator applicable to the electric light; to M. Bruno, for a writing-apparatus for blind people, consisting in a steel point, producing letters in relief on a kind of paper used for counterdrawing; to M. Masse, of Tours, a blind man, for a curious and ingenious contrivance, by which those who, like him, have had the misfortune to lose their eyesight, may express their ideas on paper by means of printing-types; to M. Colard Vienot, for an apparatus enabling the blind to write music; to M. Devisme, for an improvement in revolvers, by applying to them the principle of the Minie rifle; to M. Vitard, a carpenter, for an instrument by which the cubic contents of timber or trees may be ascertained off-hand; to J. Pouillen, for a bed, of peculiar contrivance, for patients; to M. Heilbronn, for a process by which zinc may receive a coating of paint as durable as that which may be given to sheet-iron; to M. More, for a flexible globe for the study of geography, admitting of its being folded up like an umbrella; to M.M. Lenz and Houdard, for a system of pedals and counter-pedals in

pianos, by which the highest notes may be simultaneously combined with the lowest; and, lastly, to M. Tiget, for an economical process of baking bricks.

THE GREAT EASTERN, OR LEVIATHAN, STEAMSHIP.

The following paper, descriptive of the Great Eastern Steamship, was read before the British association by Mr. J. Scott Russell, her constructor:

With respect to her size, it is generally supposed, said Mr. Russell, that, as a practical ship-builder, he was an advocate for big ships. The contrary, however, was the fact. There were cases in which big ships were good, and there were certain cases in which big ships were ruinous to their owners. In every case, the smallest ship that would supply the convenience of trade was the right ship to build. He came there as an advocate of little ships, and it was the peculiarity of the Great Eastern that she was the smallest ship capable of doing the work she was intended to do; and he believed that if she answered the purpose for which she was designed, she would continue to be the smallest ship possible for her voyage. It was found by experience that no steamship could be worked profitably which was of less size than a ton to a mile of the voyage she was to perform, carrying her own coal. Thus, a ship intended to ply between England and America, would not pay permanently unless she were of twenty-five hundred or three thousand tons burden. In like manner, if a vessel were intended to go from this country to Australia or India, without coaling *en route*, but taking her coals with her, she would require to be thirteen thousand tons burden; and, turning to the case before them, it would be found that the big ship was a little short of the proper size. Her voyage to Australia and back would be twenty-five thousand miles; her tonnage, therefore, should be twenty-five thousand tons, whereas its actual amount was twenty-two thousand tons. The idea of making a ship large enough to carry her own coals for a voyage to Australia and back again, was the idea of a man famous for large ideas — Mr. Brunel. He suggested the matter to him (Mr. Russell) as a practical ship-builder, and the result was the monster vessel which he was about to describe. He had peculiar pleasure in laying a description of the lines of the ship before the present meeting, because the ship as a naval structure, as far as her lines were concerned, was a child of that section of the British Association. It was twenty-two years since they had the pleasure of meeting together in Dublin. On that occasion he laid before the mechanical section a form of construction which had since become well known as the wave line. The section received the idea so well that it appointed a committee to examine into the matter with the intention, if they found the wave principle to be the true principle, to proclaim it to the world. The committee pursued its investigations, publishing the results in the account of their transactions, and from that time to the present he had continued to make large and small vessels on the wave principle, and the diffusion of this knowledge through the Transactions of the British Association had led to its almost universal adoption. Wherever they found a steam-vessel with a high reputation for speed, economy of fuel, and good qualities

at sea, he would undertake to say that they would find she was constructed on the wave principle. Mr. Robert M'Kay, the builder of the great American clipper, paid him a visit twelve months ago at Millwall, to see the big ship, and he then very candidly said, "Mr. Russell, I have adopted the wave principle in the construction of all my American clippers, and that is my secret. I first found the account of the wave line in the publications of the British Association." He would endeavor to explain what were the principles of the wave line as distinguished from the older-fashioned modes of building, and how they were carried out in the big ship. All practical men knew that the first thing a ship-builder had to think of was what was called the mid-ship section of the vessel, — that was the section which would be made if the ship were cut through the middle, and the spectator saw the cut portions. Mr. Russell here pointed out a diagram of the mid-ship section of the *Wave*, a small vessel about seven and a half tons burden, which was the first ever constructed upon that principle. Now, the first thing to be done in building a steam-vessel was to make a calculation of the size of the mid-ship section in the water. In sailing from one place to another, it was necessary to excavate a canal out of the water large enough to allow the whole body of the ship to pass through. The problem was how to do that most economically, and this was effected by making the canal as narrow and as shallow as possible, so that there would be the smallest quantity of water possible to excavate. Therefore it was that the ship-builder endeavored to obtain as small a mid-ship section as he could, and that had been effected in the case of the big ship, whose mid-ship section was small — not small absolutely, but small in proportion. In increasing the tonnage of a ship, three things are to be considered — the paying power, the propelling power, and the dimensions. Mr. Russell then entered into a calculation to show that while he doubled the money-earning power of a ship by increasing its size, he only increased its mid-ship section by fifty per cent. For instance, a ship of twenty-five hundred tons would have five hundred feet of excavation through the water to do; the big ship had two thousand feet of excavation, and the lineal dimensions of the one were to the lineal dimensions of the other as 1 to 2·1. The excavation to be done by the big ship in relation to that to be done by the small ship was as two thousand to five hundred feet, or four to one; but the carrying power was as twenty-five thousand to twenty-five hundred. To propel the big ship they had a nominal horse power of twenty-five hundred, while to propel the smaller vessel there was a nominal horse power of five hundred; so that the big ship would be worked quite as economically as the small one. Referring again to the wave line, he would suppose that it was given as a problem to any one to design a ship on the wave principle. The first thing to be done was to settle the speed at which the ship was intended to go. If the speed were fixed at ten miles an hour, a reference to the table of the wave principle would show that, in order to effect that object, the length of the ship's bows ought to be about sixty feet, and of her stern about forty. If a larger vessel were required, say a ship of one hundred and thirty feet long, there would by nothing more to do than to put a middle body, of thirty feet in length, between

the bow and the stern. Having then made the width of the ship in accordance with the mid-ship section agreed upon, it would be necessary to draw what was known as the wave line on both sides of the bow, and the wave line of the second order on both sides of the stern. Constructed in this manner, and propelled by the ordinary amount of horse-power, the ship would sail precisely ten miles an hour. They could go slower than ten miles an hour if necessary, and in doing so they would economize fuel in consequence of the diminished resistance of the water, whereas there would be a vastly-increased resistance if an attempt were made to drive the steamer more than ten miles an hour. Now, with respect to the big ship. For the speed at which it was intended to drive the Great Eastern, it was found that the length of the bow should be three hundred and thirty feet, the length of the stern two hundred and twenty feet, of the middle body one hundred and twenty feet, and of the screw propeller ten feet, making in all six hundred and eighty feet in length. The lines on which she was constructed were neither more nor less than an extended copy of the lines of all ships which he had built since he first laid the wave principle before the Association. It was his pride that he had not put a single experiment or novelty into the structure of the vessel, with one or two exceptions, which he had adopted on the recommendation of men who had had practical experience of their efficacy. The wave principle had never, in a single instance, deceived him as to the exact shape a vessel ought to be in order to accomplish a certain rate of speed, and he had therefore adopted it in the construction of the big ship. He would next refer to the mechanical construction of the ship, the arrangement of the iron of which she was made, and the objects of those arrangements. It was much to be desired that our mechanical sciences should make progress by the simple adoption of what was best, come from where it might; but he was sorry to say that iron ship-building did not grow in that manner. They commenced by servilely imitating the construction of wooden ships, thereby incurring a great deal of unnecessary labor and expense. There was this great difference between the strength of iron and of wood, that, whilst the latter was weak crossways and strong lengthways, or with the grain of the timber, iron was almost equally strong either way. This had been clearly ascertained by experiments made by Mr. Fairbairn and Mr. M. Hodgkinson, at the request of the British Association, in whose Transactions the results were published. The consequence was, that the ribs or frames used to strengthen wooden ships, were rendered unnecessary in iron shipbuilding; and, acting on this principle, the Wave was built of iron entirely, with bulkheads, and had not a frame in her from one end to the other. He was ashamed to say that he did not always practise what he preached. He was compelled, against his will, by the persons for whom he built, to pursue the old system; besides which there were laws of trade, acts of Parliament, and Lloyd's rule, to which he was obliged to conform. Thus, if he did not put a certain number of frames on the ship, a black mark would be put upon her, and she would not be allowed to go to sea. But whenever he was allowed to build according to his judgment, he built in what he considered to be the best way; and he believed that in what he was now placing before the

section, he was laying the grounds of meeting the British Association that day twenty years, and finding that the mode of mechanical construction which he proposed had been as universally adopted as the wave principle, because of the publications of the British Association. Mr. Scott Russell then proceeded to give an elaborate description of the old method of constructing an iron ship, contrasting it with the improved style which he pursued at present. Instead of the mass of wooden rubbish, which did not strengthen the ship, and involved enormous expense, he placed inside the iron shell as many complete bulkheads as the owner permitted him to do, and then constructed in the intermediate spaces partial bulkheads, or bulkheads in the centre of which holes had been cut for the purposes of stowage. The deck was strengthened by the introduction of pieces of angle-iron and other contrivances, and, as an iron ship, when weak, was not weak crossways, but lengthways, he strengthened it in this direction by means of two longitudinal bulkheads, and the result was a strength and solidity which could not be obtained in any other way. The Great Eastern had all these improvements, and, in addition, the cellular system, so successfully applied in the Britannia Bridge, had been introduced all round the bottom and under the deck of the ship, giving the greatest amount of strength to resist crushing that could be procured. As he had already observed, there was nothing new in the ship but her great size and cellular construction. It was true she would be propelled both by a screw and paddles, but there was no reason to doubt that they would work harmoniously.

In connection with this paper of Mr. Russell, the following notice of this gigantic steamer, copied from the Liverpool Albion, is worthy of record :

Granting that the mammoth ship is merely an extended copy of all other iron steamers built on the wave line principle, let us see what are the "one or two exceptions," so modestly alluded to by Mr. Russell before the British Association at Dublin. The most prominent, in reality, though a feature which escapes unprofessional visitors, is the cellular construction of the upper deck, and the lower part of the hull, up to the water line, or about thirty feet from her bottom, which is as flat as the floor of a room. This system, while it gives greater buoyancy to the hull, increases her strength enormously, and thus enables her to resist almost any outward pressure. Two walls of iron, about sixty feet high, divide her longitudinally into three parts, the inner containing the boilers, the engine rooms, and the saloons, rising one above the other, and the lateral divisions the coal bunkers, and, above them, the side cabins and berths. The saloons are sixty feet in length, the principal one nearly half the width of the vessel, and lighted by skylights from the upper deck. On either side are the cabins and berths, those of first-class being commodious rooms, large enough to contain every requirement of the most fastidious of landsmen. The thickness of the lower deck will prevent any sound from the engine-rooms reaching the passengers, and the vibration from being at all felt by them. Each side of the engine-rooms is a tunnel, through which the steam and water pipes will be carried, and also rails for economizing labor in conveyance of coal. The berths of the crew are forward, below the forecastle, which it is intended to appropriate

to the officers, whose apartments are at present only marked by a few uprights, rising ten or twelve feet above the main deck. Below the berths of the seamen are two enormous cavities, for cargo, of which five thousand tons can be carried, besides coals enough for the voyage to Australia, making about as many tons more.

The weight of this huge ship being 12,000 tons, and coal and cargo about 18,000 tons more, the motive power to propel her twenty miles per hour must be proportionate. If the visitor walks aft, and looks down a deep chasm near the stern, he will perceive an enormous metal shaft, 160 feet in length, and weighing sixty tons; this extends from the engine-room nearest the stern to the extremity of the ship, and is destined to move the screw, the four fans of which are of proportionate weight and dimensions. If next he walk forward, and look over the side, he will see a paddle-wheel considerably larger than the circle at Astley's; and when he learns that this wheel and its fellow will be driven by four engines, having a nominal power of 1,000 horses, and the screw by a nominal power of 1,600 horses, he will have no difficulty in conceiving a voyage to America in seven and to Australia in thirty-five days. The screw engines designed and manufactured by Messrs. James Watt & Co., are far the largest ever constructed, and when making fifty revolutions per minute, will exert an effective force of not less than 8,000 horses. It is difficult to realize the work which this gigantic force would perform if applied to the ordinary operations of commerce; it would raise 132,000 gallons of water to the top of the Monument in one minute, or drive the machinery of forty of the largest cotton-mills in Manchester, giving employment to from thirty to forty thousand operatives. There are four cylinders, each about twenty-five tons, and eighty-four inches in diameter. The crank-shaft, to which the connecting rods are applied, weighs about thirty tons. The boilers are six in number, having seventy-two furnaces, and an absorbent heating-surface nearly equal in extent to an acre of ground. The total weight exceeds 1,200 tons, yet so contrived that they can be set in motion or stopped by a single hand.

Sails will not be much needed, for in careering over the Atlantic at twenty miles per hour, with a moderate wind, they would rather impede than aid; but in the event of a strong wind arising, going twenty-five miles per hour in the course of the vessel, sails may be used with advantage, and the Great Eastern is provided accordingly, with seven masts, two square-rigged, the others carrying fore and aft sails only. The larger masts will be iron tubes, the smaller of wood. The funnels, of which there will be five, alternating with the masts, are constructed with double casings, and the space between the outer and inner casings will be filled with water, which will answer the double purpose of preventing the radiation of heat to the decks, and economizing coal by causing the water to enter the boilers in a warm state. Her rigging will probably cause most disturbance of ideas to nautical observers, for, besides the unusual number of masts, she will want two most striking features of all other vessels, namely, bowsprit and figure-head. Another peculiarity is the absence of a poop. The captain's apartment is placed amidships, immediately below the bridge, whence the electric telegraph will flash the commander's orders to the

engineer below, helmsman at the wheel, and look-out man at the bows. In iron vessels great precautions being necessary to prevent the compass from being influenced by the mass of metal in such attractive proximity, various experiments have been made with the view of discovering the best mode of overcoming this. It was originally intended to locate the compass upon a stage, forty feet high, but this plan has been abandoned, and a standard compass will be affixed to the mizzen-mast, at an elevation beyond the magnetic influence of the ship.

The preparations made for launching the "Leviathan" are of a novel character, and have been described as follows: —

Two strong and powerfully-built tramways have been constructed, running from under the fore and aft portions of the vessel down to spring tide low-water mark. Each of these ways is 300 feet long by 120 wide, and the distance between them is also about 120 feet. To guard against the shifting nature of the river mud, the ways are constructed with unusual solidity and strength. The foundation of each is formed upon seven rows of piles, the four outside rows being driven in at three feet intervals, and the inner rows at six feet. These piles are all forced home to the gravel of the river's bed, so that they graduate from thirty-two feet long under the ship's bottom to ten feet at low-water mark. To both sides of the pile-heads strong timbers are securely bolted, and the whole area covered with concrete to a thickness of two feet. Above the concrete longitudinal timbers of great strength are secured at intervals of three and a half feet, and run the entire length. Over these again are transverse timbers, three feet apart, bolted down, to keep them fixed under the pressure they will have to bear, and to prevent them floating at high tide. On these, but running straight to the water, railway metals are screwed at intervals of eighteen inches. The rails complete the launching ways, which thus form a massive road, stretching from under the ship to low-water mark, at an incline of one in twelve. Down these ways the vessel will be slowly lowered into the water on the cradles under her, which are constructed of large hulks of timber, wedged with a ponderous machine like a battering-ram, so as to perfectly fit the ship's bottom. The timbers are laid principally athwartships, with longitudinal beams fastened to the outer sides, and all are bolted together, and loaded with iron to prevent their floating with the vessel. The bottom of the cradle consists of iron bars, placed at intervals of a foot, and with their edges carefully ground off, so as to offer no resistance to the metals over which they will have to pass. Both launching ways rise slightly in the centre, in order to allow for the depression which is certain to be produced by the passage of such an enormous weight over their surface. Before the launch the metals will be thickly coated with a composition of tallow and black lead, so as to offer no obstruction.

The chief points upon which the energies of Mr. Brunel have been concentrated were, first, to overcome the momentum of such a mass down an incline of one in twelve, and prevent her, when once in motion, from dashing entirely away; secondly, if stopped from any cause upon the ways, to provide sufficient purchase from the water to slowly pull her into motion again.

As far as human ingenuity and skill can foresee, the former danger has been provided against, and the apparatus forms the most ponderous system of check tackle ever constructed. To the centre of each cradle is fastened the iron sheave to which the check tackle is attached, weighing five tons. Wrought iron chains of the largest size connect these with two other sheaves, each secured to a drum, which pays out the chain and regulates the whole operation. These drums and the framework on which they rest having to bear the strain of the whole mass in motion, extraordinary precautions have been taken to render them as massive as they could be made by any known combination of wood and iron. The axles are formed of beams of timber and strips of wrought iron bound together, forming a drum twenty feet long and nine feet in diameter. The discs are solid iron, sixteen feet in diameter, and weighing upwards of twenty tons, so that the weight of each drum is more than sixty tons. The axle is set in an iron frame, and round its outer edge passes a band of wrought iron, to work in the manner of a break, which, with the aid of strong iron levers, twenty feet long, brings such a pressure upon the drum as to lessen its revolutions, or entirely stop them, in case the chain is being paid out too fast. Our readers may naturally ask what holds the drums themselves? The frame in which the work is set is a solid piece of timber, formed by driving piles forty feet in length, and going down to the gravel. The whole is bound together with iron, and strong shores pass from the piles to the bed of piles on which the ways are constructed; so that, whatever the strain, it would be impossible for the setting of the drums to give way unless the river bank gave way with it.

These are the appliances for preventing the monster running down too fast; but a powerful apparatus has been devised to act in a contrary manner, namely: to pull her off the ways in case of her sticking fast on them through any unforeseen *contretempts*. For this purpose four lighters are moored about 100 yards from the shore, fitted with crabs and sheaves. Each crab gives a strain of sixty tons, and this force of 240 tons, if necessary at all, is to be applied amidships. Two lighters will also be moored at the stem and two at the stern, and the chains passing to these from the ship will return on shore, so as to be worked with a double purchase. Stationary engines of twenty-horse power will haul in the chains, making the whole force available to pull the vessel off upwards of 600 tons.

It only remains to add, as a matter of scientific record, that since the above was written the launch of the great steamer has been effected.—*Ed.* attempted. — *Editor.*

ON SCREW PROPELLERS.

The following communication on the above subject, by Prof. W. R. Hopkins, U. S. Naval Academy, is copied from Silliman's Journal: —

Is it not strange that while in heavy machinery on land revolving at high velocities no difficulty is found in preventing heating in the journals, from friction, that few propellers are afloat at sea that have not suffered seriously from this cause? We hear of vessels on both sides of the Atlantic, mercan-

tile and armed, that are retarded by the heating and wearing in the stuffing boxes and bearings of their shafts.

It appears to the writer that the causes for this can be easily explained, and the effects modified if not prevented. The heating of the bearings inside a vessel results from one cause: the wear and heat in the stuffing box and outside journals result from totally different causes.

In most cases the machinery of a steamship is placed in the centre of the vessel, and thence motion is carried to the propeller blades by a long shaft rigidly connected. If the frame of the vessel springs at all by the motion of the sea, the shaft is thrown out of line, and must consequently heat. To remedy this the shaft should be allowed some play in the couplings where the *lengths* of the shaft are joined together.

But it is the wearing of the journals and bearings outside the vessel that is most prejudicial, most frequent, and most difficult of repair. One cause of this wear is that the blades are not made smooth and not balanced, so that the centre of rotation and the centre of gravity do not coincide. No machinery in revolving works well under these circumstances.

But the most important disturbing cause is the following. The propeller blades of a vessel on leaving port are set in motion in a plane at right angles to the vessel's keel. The propeller blades tend to "persist" in this plane, and the greater their momentum the greater their resistance to any cause tending to draw them from this plane. But the motion of the vessel is a constant disturbing cause, and in resisting the motion of the vessel the revolving propeller presses with great force on the bearings.

Suppose, as in some vessels, the propeller (blades and hub) to weigh fifteen tons. Propellers of this size have their centres of oscillation moved at the rate of thirty-six feet per second when in full action. We have then a weight of fifteen tons moving at thirty six feet per second, to be deflected from its line of action whenever the vessel rises or falls. The wear caused by this action has been attempted to be overcome by putting wooden linings in bearings; how far successfully has yet to be shown.

It would undoubtedly be better to remove the cause than to remedy the effects. It seems to the writer that the cause may be easily removed by simply so arranging the propeller blades (or the frame in which they are mounted), that the propeller blades can keep in the original plane of rotation however the vessel may move in a sea way. The plans for effecting this are not easily explained without drawings. But means of so arranging the propeller blades that they will keep vertical however the vessel may move will occur to most persons acquainted with machinery.

MASKEL'S SLIDING KEEL.

This invention consists of a plate of iron, or other suitable metal, which is moved vertically in a recess made for it in the keel. A link at each end attaches the plate to the keel, provision being made by slitting the pin-holes of the links, to allow for the raising or lowering of the plate, which is accomplished by racks and pinions, or other suitable machinery, worked on the vessel's decks, the attaching rods passing through water-tight tubes ex-

tending from the top side of the keel to the deck. The depth to which the sliding keel can be lowered, is of course limited by the depth of the main keel; being somewhat less, but its length being nearly that of the main keel, a sufficient area is presented to prevent that motion of the vessel technically termed "flatting off," which would otherwise take place under a side wind. The old fashioned sliding keel is objectionable, as the "well" or opening in which it slides runs fore and aft of the vessel, for one-fourth or one-third of her length, and requires the deck beams and frames for that length to be cut entirely through, thereby much diminishing the strength of the hull. Mr. Maskel's plan requires no such sacrifice; nothing is cut through; but the hull is built in the usual way, except the recess in the main keel. For vessels navigating the shallow rivers and bays of our Southern coast it must prove valuable, particularly in the cotton districts, where the largest vessels of deep draught, unable to come in, are loaded by means of lighters. The plan is favorably reported on by a commission of United States Naval officers, and is approved by some of the most eminent naval architects of the country.

NOVEL STEAM VESSEL.

There is now in the course of construction, in London, a small steamship, built of iron upon a new principle, which the builders believe will accomplish an average speed of from twenty-five to thirty miles an hour. The invention, for which a patent has been obtained, is intended to be applied to special transit vessels only, and is not suitable to river steamers, or other vessels intended to be used where the water is shallow or the channels uncertain. Should the expectations of the builders be realized, a vessel built and fitted in the manner proposed can make the voyage from Liverpool to New York in five days, or from Liverpool to Melbourne in forty days. The novelty of the invention consists for the most part in constructing the vessel so that the centre of gravity is placed below the water line. This is effected by constructing a chamber called a "well" all along the bottom of the vessel, in which the machinery, coals and stores can be deposited. As it is not proposed that the vessel shall carry cargo, the centre of gravity will thus become a suspended instead of a supported body; and it is believed that this peculiar formation will materially decrease the area of resistance to the water. The sides of the vessel rise perpendicularly from the well; and although the appearance of the vessel at present is anything but graceful, the patentee is of opinion that her form is constructed so as to secure the greatest amount of speed compatible with safety.

The improvements proposed to be carried out may be shortly described area as follows: 1. Vessels built according to this plan show a decrease in the of resistance to the water full thirty-five per cent. when measured against any other vessel of the same breadth of beam and draught of water, thus insuring greater speed. 2. They have a better disposition of the centre of gravity, a consequent increase in stability, and a decrease in the amount of oscillation, enabling them when required to carry a larger quantity of canvas than other vessels of the same size. 3. The engines are so constructed as to effect economy in space and weight, causing also a saving of coals equal

to a sixth of the consumption of other marine engines. 4. The screw-propeller possesses greater power of propulsion than any other propeller yet introduced, by at least thirty per cent. 5. Attached to the engines is a powerful steam signal whistle, so constructed as to give out a code of signals, by which captains of ships may communicate with each other, by sounds perfectly intelligible, at a distance of three or four miles apart. The object of this portion of the invention is to prevent collisions at sea during dark nights or foggy weather. The novelty in the steam-propeller is confined to the manner of fixing the fans, so that each blade when revolving will clear the other of back water. This adaptation seems extremely simple. The introduction of a buoyant drum or boss, in which the root of the fan is fixed, also reduces the weight of the shaft by about two-thirds. The trial vessel, which will be ready for launching in a few days, is of sixty tons burthen, and when fitted with her engines and stores will weigh only fourteen tons. She is formed of plate iron one-eighth of an inch thick, with angle irons an inch and a half thick, and ribs fifteen inches apart. The inventor proposes to take her to New York when finished. There can be no doubt that light iron steamers, without cargo, and driven by high-pressure engines, can attain very great speed in passing through the water, but it would be premature to assert that the vessel now building will realize all the anticipations which the builders have formed of her powers.

Large Screw Steamer. — The largest Screw Steamer hitherto constructed has been launched at Glasgow during the past year. She is intended for the Australian trade, and rates as of 1800 horse power. She is 2,800 tons burthen; beam, forty-two feet; length over all, 360 feet; depth of hold, thirty-one feet. She has two direct action engines, six tubular boilers, and a three-bladed propeller. She will carry 900 tons of goods, and her bunkers will stow 1,500 tons of coal — enough for twenty-four days at full steam. It is unnecessary to say that this vessel is of iron, as none but iron screw-propellers are made in England. The number of these vessels is rapidly increasing in the mother country, and they seem destined to supersede all others in the transportation of goods of some value.

CLIFFORD'S INVENTION FOR LOWERING BOATS.

The following is a detailed description of Clifford's plan of lowering boats at sea, which has been already alluded to in the Annual of Scientific Discovery for 1857. The object of this important invention is to enable a man placed in a suspended boat to lower it safely at a moment's notice, whether it be empty or full of passengers, and whether the sea is smooth or rough, whether the ship is at rest or in motion. In the centre of the boat, across the keel, is a small windlass; at both ends an ordinary pulley is fastened to the keel, and immediately over each a friction pulley, (which will be described hereafter) is suspended by ropes attached to the sides of the boat. The boat being raised to the proper height by the usual means, and the ends of two suspending ropes of exactly the same length being firmly secured to the extremities of the davits, their other ends are passed through the friction pulleys, through the pulleys on the keel, and are loosely inserted in holes

bored for the purpose through the windlass. Preparatory to this, a long rope, fastened to the windlass, had been wound around it; and this rope is now pulled upon, and the suspending ropes are in consequence wound round the windlass, and kept tight by securing the winding rope. The pulleys by which the boat has been raised are unhooked, and she is left suspended to the davits. For the purpose of lashing the boat to the ship, there are on each davit two iron prongs, one nearly as high as the gunwale of the boat, and the other two feet lower than her keel. These prongs extend directly downward, so that any ring or thimble passed up them would fall by its own weight, if left unsustained. Ropes with thimbles at their ends are next hooked to the prongs, those from the upper prongs being passed over the nearest side of the boat, those from the lower ones under her and over the other side, while all four are tightly fastened inside of her. The boat is now suspended, prevented from rocking and ready for service. The process of lowering is obvious; a man enters the boat, unfastens the winding rope, which he allows to run fast or slow as he pleases. The weight of the boat unwinds the suspending ropes, which finally slip from the holes in the windlass and remain hanging from the davits. The thimbles of the lashing ropes in the mean time slip from the prongs and remain hanging from the sides of the boat. In this operation the force of a man is made sufficient to control the weight of a boat by means of the friction pulleys above mentioned, the effect of which is analogous to that of a turn or two of a rope around a post, as exemplified every day on the arrival of a steamer, when one man by this process checks the motion of a boat of a thousand tons. The friction pulley consists of a block with three sheaves placed one above the other, their centers in a straight line, their sides on the same plane and their axles parallel. The rope is made to wind its way from the right of one sheave to the left of the next, and once on, has the shape of a cross section of a hollow rail. The nearer the sheaves are to each other the sharper the turnings of the rope, and the stronger the resulting friction. Another precaution which it is always prudent to take beforehand, is that of fastening the helm on the proper side for turning the head of the boat away from the ship. But this must be done carefully, for if it be turned too much on that side and the boat lowered from a steamer at full speed, mishaps might occur. This invention has been thoroughly tried on board several vessels of the English Navy. It is found to answer beyond expectation, and is now adopted by the Admiralty.

STEAM ON COMMON ROADS.

Considerable attention has been excited in New York during the past year by the occasional appearance on Broadway of a street locomotive, built by Mr. Richard Dudgeon. Its speed was about equal with the average speed of horses in stages, and it was apparently controlled with as much ease, and with more certainty. The popular notions that horses would be alarmed by such vehicles, and that they cannot ascend hills on account of their wheels slipping, were refuted by the performance of this engine, which met with no

case of difficulty of this nature, although it run for a considerable part of several days in crowded streets.

Mr. Joseph Battin, of Newark, N. J., has also recently built a steam carriage on a different plan, which he has run successfully on several short trips. The performance is such as to corroborate the view that steam may be used with advantage, even on a small scale.

It is known to most well informed persons that there were about seventy steam carriages built in England between 1827 and 1840, many of which were reported to have attained speeds of twenty to thirty miles per hour with full loads, and to have worked more economically than horses, and to have been free from the objections attributed to them by popular rumor, such as that they would make smoke, throw out sparks and dust, frighten horses, slip their wheels, and be unable to steer well and stop quickly.

In reply to all reports of these favorable performances, from 1831 down to this day, the question has been asked: "How happens it, if these reports be true, that capitalists or practical engineers have not brought the invention into common use?" It seems on all hands to have been inferred, from the fact it has not come into use, that the invention is incapable of competing with horse-power, in point of economy, or that it is dangerous or otherwise objectionable.

To this question, Mr. John Fazey, author of a well known Treatise on the Steam Engine, in his testimony before a committee of the House of Commons on steam carriages, replied that the protection by patents was insufficient to induce business men to incur the expenses that attend the introduction of a new invention. The first machines always cost more, and generally are far less efficient than those built after there has been time to effect the details and proportions, and methodize and cheapen the construction; and unless it is tolerably sure that the invention will not be open to competition, there is no inducement to incur the certainty of extraordinary expense in the outset, even if there were no apprehension whatever that the enterprise might fail from defects of the invention. There were at that time and soon after, six different plans, nearly equal in merit, which had no patentable features but their boilers; and the proprietors of these plans were in competition, and some of them were hostile to each other, and disputed in public print, and even opposed each other in applications to Parliament; these proceedings indicated that there would be such competition as would prevent capitalists from obtaining high profits, however useful the invention might prove to be; and it was observed that after the coming up of these competing plans, there was little capital subscribed, although immediately after the first successful demonstration by Gurney, abundance of capital was subscribed, on condition that Parliament should sanction the enterprise, by granting charters and repealing Prohibitory Toll Acts.

In 1831 Gurney and his supporters petitioned for the abatement of tolls, which were from two to thirteen times higher on steamers than on horse coaches of equal capacity. The Commons appointed a select committee to examine into the merits of the invention or the obstacles in its way; which committee, after receiving the testimony of several eminent engineers, besides

that of the parties interested, reported that the invention was able to work cheaper than horses; that it was speedier, safer, more agreeable, and less injurious to roads than horses; and that it was subject to Prohibitory Tolls; and the committee reported a Bill to make the tolls equal to those on horse carriages, which Bill passed the Commons, but was rejected by the Lords.

In 1834 Gurney again petitioned; another investigation took place, but the case was laid over until 1835, when another committee resumed the subject, and a Bill was passed to relieve steam carriages from Prohibitory Tolls, and to extend Gurney's patent, which had nearly expired. This Bill the Lords rejected, in consequence of which the capitalists withdrew, and the invention was left to the zeal of enthusiasts, who worked with little or no hope of money, and who were easily crushed by the strong opposition of established interests.

It is remarked in the history of this invention, that it might have attained the sanction of Parliament, and attained complete success, had there been a company committed to no particular invention, yet controlling them all, and adopting and combining what was best in all. The same remark, we think, is now applicable to the invention as it stands in this country. And we may add that the view of Fazey applies with greater force than it did when the locomotive was undeveloped, and the competing steam carriage plans were in some measure protected by patents. Capitalists will keep aloof from it unless it is presented in such a condition that they may expect a monopoly of the plans which they pay for perfecting and introducing. They will not pay the extraordinary expenses of new machinery, and of repeated partial failures, if, when they have shown that the general project is economical, those who wish to use them can get their models copied at mere workmen's prices, or run them down by the force of superior capital.

Inventors usually are actuated by love of invention, and do not comprehend the motives of money-making men. They are also partial to their own devices; and, though not more selfish than other men, they are often at variance with each other, and weaken themselves until they fall an easy prey to the lowest class of capitalists. It appears that this invention has heretofore failed from the division of those whose plans, if combined, would have insured its success; it is to be hoped their error will save the invention from a like fate at this time, when it seems to be exciting renewed attention, both here and in England.

FEEDING OF STEAM BOILERS BY METER.

The owners of steam machinery are well aware that it is by no means an uncommon occurrence for the shortcomings of one portion of their arrangements to be unwittingly attributed to another and innocent department. In this way, the engine and its boiler are often mixed up, as to their respective merits and defects, very much to the confusion of their qualities, the perpetuation of uneconomical working, and the betrayal of the confidence of the employer.

Every steam boiler and every engine ought to stand for itself; and each must support its own individual credit. What goes on in the steam cylinder

is, of course, already clearly told by the indicator, and many are the valvular defects and derangements which the mechanical engineer has proved and remedied by the help of this little instrument. Now there is no reason why the "indicator" system should not find equally as good an application with reference to the real source of the power — the steam boiler. At present we put coals into the furnace, and pour water into the boiling chamber for conversion into steam, whilst we have no satisfactory return to show whether each pound of fuel does or does not produce the amount of mechanical effect which is exigible from it. But such an explanatory statement can now be obtained in a very simple and accurate manner, by mounting guard upon the water feed-pipe of the boiler with a good water meter. Each boiler must, of course, have its own special meter, so that, however many boilers there may be working in concert, the truth is always told as to the performances of every individual one.

IMPROVEMENTS IN STEAM BOILERS.

George Jackson, of England, has patented "a new or improved steam boiler, to be heated by the waste heat of puddling or mill furnaces." The boiler is of cylindrical form, and is terminated by hemispherical or nearly hemispherical ends. The boiler is set in its casing of brickwork in a vertical position, and the hot air and the fire are made to circulate about and through the said boiler in the following manner: — "The fire is conducted from a couple of puddling or mill furnaces through two flues, and delivered near the bottom of the boiler. After being made to circulate about the vertical sides of the cylindrical boiler, the said fire enters a horizontal flue passing through the boiler at a point a little higher than its middle. The fire enters the horizontal flue at both ends, and passes up a vertical flue or chimney, which is situated in the axis of the boiler, and opens into the horizontal flue. A damper is situated at each end of the horizontal flue, and by the dampers the draught may be regulated. That part of the vertical chimney which is within the boiler is surrounded with an air space, that is to say, there is an annular layer of air between the chimney and the boiler, so that the chimney is isolated, so far as its temperature is concerned, from the upper part of the boiler. The isolating air space descends to a point below the water level of the boiler, and any danger which would otherwise attend the over-heating of the chimney is avoided."

Wright's Improvements in Manufacturing Boilers. — In the ordinary manufacture of cylindrical boilers, the plates are so arranged that the riveted joints run in lines parallel to the axis of the boiler, and in planes perpendicular to the axis; or, in other words, the joints run in the direction of the length of the boiler, and at right angles to it. The joints running parallel to the axis of the boiler, or the longitudinal joints, it is well known, are subjected to a greater strain than those crossing them at right angles and running round in planes perpendicular to the axis, and consequently the longitudinal jointing is the weakest, and the part of the boiler first to give way under great pressure.

In order to remove this defect, Mr. E. T. Wright, of Wolverhampton,

England, has patented an invention which consists in so arranging the riveted joints of boilers, and other articles of similar manufacture, that they shall not run parallel to the axis, but in a line oblique thereto, the lines of plates being made to run round the axis of the boiler in a helical or corkscrew direction, and the joints either at right angles to one another, or varying from a right angle, so as to be oblique to the direction of the greatest strain. "By thus placing the lines of riveted jointing oblique to the direction of greatest strain," says Mr. Wright, "any given amount of such greatest or lateral strain is resisted by a greater length of jointing, and consequently greater number of rivets, than when such line of jointing is situated parallel to the axis of the boiler; whilst the whole length of jointing and number of rivets in the boiler is not increased, or is increased only to an inconsiderable extent."

Mud Pockets for Steam Boilers. — J. Stephen, of Glasgow, has taken out a patent for the following method of constructing boilers, to collect and remove the mud deposited from impure water. The boiler is formed with a narrow water space division, or pocket, extending from the underside of the boiler at the furnace down to and through the line of furnace bars. The water space opens at its upper wide end into the bottom of the boiler, which has a row of openings in its shell at that part to form the communication. The boiler itself is set slightly out of the horizontal line, the furnace end being somewhat lower than the reverse end. Hence the mud and deposit of the water is continually directed towards the front or furnace end where it falls from the boiler into the narrow bottom of the water space or pocket. The part where the deposit accumulates is carried down to a short distance below the furnace bars, so that the heat of the fuel cannot act injuriously upon the metal of the division space, and burn it where there is no water to protect it. The mud or sediment which accumulates in the bottom of the water space can be removed by an instrument put in either from the interior of the boiler, or through a plug way in the front end of the water space. Loose deposit can, of course, be blown out through the plug way by the steam pressure of the boiler. The water space, being passed down into the furnace in the centre thereof, forms the means of dividing the furnace into two equal parts, so that the sections can thus be fired alternately.

ERICSSON'S HOT AIR ENGINE.

Ericsson's caloric motor or hot air engine, which had been nearly forgotten by the public, and was supposed to have been laid aside as ingenious but impracticable, is again brought to notice and now seems to be decidedly successful. Though the principle on which Ericsson's caloric engine was originally built is wholly preserved, the arrangement and mechanism are entirely different — the whole being reduced to a degree of simplicity never before attained in any engine.

Several of these engines have been exhibited in New York during the past summer. One, located in an office in William-street, occupies less than a cubic foot of space, and is heated solely by gas. The power develloped by it, is greater than that of an able-bodied man. It is employed in

pumping, and raises three hogsheads per hour to an elevation of five feet. This pattern is called a "domestic engine," being adapted to perform a great variety of work ordinarily done by hand, and with a surprising degree of economy.

Another pattern is designed for ships' use. In this capacity, it promises to accomplish important results; for our fine large packets and sailing ships, being unable to carry steam engines, have wholly to rely on manual labor in ridding the ship of water, in case of leak or other exigency. The caloric engine may be placed in the corner of the cook's galley, almost unobserved, and may be put in operation in fifteen or twenty minutes, saving the labor of an entire crew. There being no possibility of explosion, or rather disaster, the cook is amply qualified to officiate as engineer, if desired.

In addition to the above, a steam yacht has been running in New York harbor during the past summer, propelled solely by caloric. This boat is fifty feet in length, with an eight feet paddle wheel, which works about thirty turns per minute, giving a speed equal to eight or nine knots an hour. The engine is controlled by any one who happens to belong to the party on board. The fuel is either coal or wood. Small oak wood has generally been used, sawed into eight-inch lengths, and incredible as it may seem, only *one cord* was consumed during the last six weeks, though the boat was in motion more or less every day! Even after the fires are wholly extinguished, sufficient heat is retained in the metal of the engine (if it has been thoroughly warmed, and is in good working order) to propel the boat at least two miles. The space occupied by the engine of this boat is not larger than the boiler which the same boat would require if propelled by steam.

Mr. Ericsson deserves great credit for the patience with which, under great discouragements, he has elaborated and perfected his invention, and we hope he may now reap an abundant reward.

NEW SAFETY ESCAPE-PIPE FOR STEAM BOILERS.

At a recent meeting of the society of Arts, London, Mr. John Ramsbottom read a paper describing a new and improved mode of applying the fusible plug to steam boilers, so as to secure the greater certainty of its action and to remove one of the principal causes of boiler explosions, namely, that arising from shortness of water. It occurred to the author, that if the plug or plugs were inserted in a small flue or pipe, through which a current of the hottest gases taken immediately from near the fire was made to pass such flue or pipe, being at the same time at a higher level, than the boiler surface over the fire, that the fusible plugs would be melted out with greater certainty, whilst at the same time the boilers not being overheated would be uninjured. The modes in which the invention could be applied to various descriptions of boilers was shown by drawings, and the manner in which the invention acted was described. An elbow pipe four inches diameter was fitted to the bottom of the boiler, or to the top internal flue of a boiler and was made the means of carrying the heated gases from the furnace to the side or exit flue. The upper part of the elbow pipe being perforated with

conical holes five-eighths of an inch diameter, and filled with fusible metal plugs, simply driven in. By this arrangement should the water fall below the upper surface of the pipe, the fusible plugs being constantly exposed to the current of the heated gases, passing through it immediately melt, and thus preserve the boiler from injury. The pipe could be made of wrought or cast-iron, brass, or copper, but the author preferred them, of wrought iron or malleable cast iron. Before venturing to bring the plan before the public, he made several experiments upon one of his own boilers. At the time the experiments took place, the pressure of the steam averaged from forty to forty-five pounds the square inch, the water then being at its proper working height, that is to say, three or four inches above the covering in, or top of the side flues. To facilitate the experiment, the water was blown off until its level was not more than one fourth of an inch above the top of the pipe. Instructions were then given to the stoker, to fire up, and increase the steam pressure, with a view to evaporate the water as quick as possible, and reduce it below the proper level. Through a spy hole made in the brickwork the action of the fire could be distinctly observed playing upon the plugs until they melted out. It was subsequently found that three of the plugs had given way, thus relieving the boiler from steam pressure, and gradually putting out the fire, while a sufficient quantity of water was reserved to enable the stroker to recommence firing, with but little delay of the replacing of the plugs.

ENGINES OF THE BROOKLYN WATERWORKS.

The largest pumping engines in the United States, and, with few exceptions, in the world, are those in course of construction for the Brooklyn Water Works by Messrs. Woodruff and Beach of Hartford, Conn. Each of the two engines will lift 10,000,000 gallons to an average height of 165 feet per day of sixteen hours, through a tube thirty six inches in diameter and about 3,300 feet long.

The conduit of the Brooklyn Water Department is situated some 130 feet below the great distributing reservoir, and powerful engines are necessarily required to raise the water. The two machines now in course of construction are double-acting fly-wheel engines of ten feet stroke and eighty inch bore, each working two pumps of fifty-four inch bore and thirty six inch effective stroke, by spiral cams.

This is a modification of the Hartford pumping engine, built by Messrs. Woodruff and Beach, in which the fly-wheel shafts gear, with two pump-shafts, each driving two pumps and reducing their speed to one third that of the fly-wheel shaft. The four pumps are each fitted with double pistons, worked by the cams, alternately toward and from each other, with a lap on the upper and lower centres, so that the water is lifted without changing its direction, as in other double-acting pumps. In the Brooklyn engines, only one pair of pumps will be used for each, the piston of one working its charge through the other, the effective stroke of each being thirty six inches with forty-two inch travel, and the cams being connected directly to the fly-wheel shaft. Double-beat valves are also to be used

The duty established as a test of these engines is 600,000 pounds of water raised one foot, with one pound of coal; the water being measured by actual discharge into the reservoir. The trials of the Hartford engine, gave, in one case, 620,000, and in another, 690,000 pounds duty.

The engines used at Cambridge, Mass., for working the pumps of the water-works, have the following peculiarities: Two trunk engines work the pumps by direct action, each combining the use of high and low pressure steam. The high pressure cylinder is placed within the other, and, instead of allowing the exhausted steam to escape, it is carred back through passages in the covering of the outer cylinder; and made to enter this outer or low-pressure cylinder at the same end as it enters the first; here it acts, expansively, and is finally conveyed through the side supports of the engine into the condenser. The piston of the outer cylinder is a ring, and its power is transmitted by three piston-rods instead of one, which are bolted to the same cross-head, or yoke of iron, as the single piston-rod of the inner cylinder; thus the powers of the two cylinders are combined to effect the same object at the same moment. The inner cylinder is kept warm by the steam in the outer one, and this again by a small quantity of steam which is admitted for that purpose into its hollow cover or jacket. The diameter of the small cylinder is twelve inches, and that of the large twenty-four inches, its piston being a ring five inches wide. The plunger of each pump displaces about sixteen and a half gallons of water each stroke.

COAL-BURNING LOCOMOTIVES.

Numerous abortive attempts have been made during the last ten years, for substituting coal for wood as fuel for locomotives. When it is known that all over Europe coke is used as successfully as wood is here, it is not easy to understand why there should be any difficulty in using anthracite, but practice has taught that there are many. There are now three different plans before the public, and they are all approved by competent engineers. A locomotive on the Baker plan has been constructed for the Providence and Fall River Railway Company. The novelty consists in making the flames follow a curved flue, instead of going straight to the chimney. The smoke is thus more thoroughly mixed with air, and consequently better burned. There is also an arrangement to supply the furnace with warm air. It is alleged that the result will be a saving of fifty per cent.

Another locomotive is in use upon the Hudson River rail-road, the invention of A. F. Smith, Superintendent of that road. This machine weighs 59,000 pounds, the driving-wheels are five feet in diamater, the stroke is twenty-two inches, the boiler is forty-nine inches in diameter and eleven and a half feet long. The barrel proper, extending from the flame-sheet to the smoke-arch, is seven and a half feet long and forty inches in diameter. There are 179 brass tubes, of two inches outside diameter and seven and a half feet long. The fire box measures sixty by thirty-two inches, with a combustion chamber extending four feet into the barrel of the boiler. This chamber is divided by a water leg, extending from the front of the fire-box to within twenty inches of the tube sheet. Around the

combustion chamber there are apertures which are opened or closed at pleasure, and by which air can be let in to burn the gases not yet consumed. The consumption of coal on the first trip, between New York and Poughkeepsie, was 4,200 pounds instead of the usual four cords of wood; that is to say, thirteen dollars and twenty-five cents instead of twenty-eight dollars. Dimpfel's tubular boiler is intended for any kind of fuel, and, it is alleged, answers perfectly for coal-burning locomotives. A large machine of this style was built by the Taunton Locomotive Manufacturing Company, and is now drawing express trains over the Erie Railroad, using anthracite alone. The fire-box and the barrel form one chamber, through the whole length of which the smoke passes, escaping into the smoke-box through an opening in the lowest part of the barrel near the smoke-box. The tubes extend out of the barrel over the fire; there they bend upward, and the top of the furnace becomes a tube sheet. With this arrangement the water is inside the tubes and the fire outside between them, in the manner adopted for the boilers of the Collins steamships. The inventor claims to have by this arrangement entirely done away with the burning of the end of the tubes and of the top of the fire-box, which is the ordinary consequence of a coal fire in a locomotive built on the usual plan.

IMPROVEMENTS IN LOCOMOTIVES AND RAILROAD CARS.

Prestage's Improved Locomotive. — This invention is attracting considerable attention in England, and is similar to the one used on the steamer Arctic at the time of her loss. It aims at fulfilling the conditions suggested by the Franklin Institute as being necessary for the economical working of superheated steam, — the committee reporting that there would be great economy in using superheated steam or stame, if it could be brought into operation where the temperature of colder bodies would not interfere to abstract the heat before it could be profitably employed. The cylinders and working parts of the machine are placed above the boiler, instead of underneath, as is usual, and the boiler is in consequence lowered, thus giving more stability to the engine and bringing its centre of gravity more directly to the line of attraction. The removal of mechanism from under the boiler leaves a space available for the construction of a tank, which surrounds it in such a manner as to maintain against the boiler a sheet of feed water, which is there heated by the radiating heat preparatory to its being fed in. The cylinders are encircled by jackets, and are placed in the smoke-box. The steam in its passage from the boiler to the cylinders, is led into these jackets, where it is superheated. It is expected that the consumption of the fuel will be diminished one half by the use of this invention. This expectation is by no means unreasonable, when we remember that a locomotive uses about three times more fuel per horse power than the most expensive stationary engine. Besides, the use of stame in lieu of steam does not require so large a boiler, and the room thus gained allows an increase of the furnace sufficient for the use of coal, which is a cheaper combustible than wood or coke.

New Form of Locomotive. — A new form of railroad locomotive has re-

cently been constructed in England. The steam cylinders are placed midway between two pairs of driving-wheels, which are so disposed as to bear nearly the whole weight of the engine. A third pair of wheels are added, as leading or travelling wheels, to complete the six required for the safety of the engine. The cylinders are fitted and worked the usual way, but, instead of having the piston passing out at one end of the cylinder only, it is carried through both ends of it, which are filled with stuffing boxes. This plan saves the piston from undue friction. The cylinders are fitted and furnished with connecting rods at the ends of the pistons, one set of connecting rods communicating with one of the cranks on the leading driving wheel axle, and others with the cranks of the rear driving wheel axle. By this arrangement the cylinders and pistons act in opposite directions, and the tendency to oscillation is avoided.

Automatic Steam Whistle. — This is the invention of Mr. James Harrison, Jr., and is a mechanical attachment to the engine, worked from the forward truck axle, upon the principle that the axle makes a certain number of revolutions in working over the same distance, without any regard to the speed. The motion is carried up to and along the top of the boiler to a cast iron hollow cylinder, eight or ten inches in diameter, which is placed vertically upon the boiler at the point where the whistle is to be fixed. On this cylinder a screw is cut, intended to be long enough for adaptation to the route of the locomotive out and back. Between the threads of this screw a lever slowly traverses, and at the points where the whistle is to be blown, pins are placed, over which the lever rides and raises a corresponding one, acting upon the valve of the whistle on the top of the cylinder.

Improvement in Journal Boxes. — We notice the following improvement in journal box for railroad car axles. It consists in making an inner box or cell, with projecting lips, which embrace the lower half of the journal, to fit and slide in recesses in the sides of a brass or cap box, so that when the journal is inserted, and the inner box or cell is forced up against the journal by springs, the whole circumference of the journal shall be embraced, to prevent the entrance of dirt and waste of oil.

Improvement in the Manufacture of Car Wheels. — An improved method of manufacturing wheels and axles is now being largely carried on in England. The wheel is composed of triangular sections, each triangle being formed of a rolled iron bar, bent into the required shape by a most ingenious operation, the base of the triangle being slightly curved, so as to form a perimeter of the wheel; the ends are either inserted in a wrought iron nave; and, by the insertion of a piece of iron at the angle of each triangular section where it joins the next section, these being welded to each section, the wheels become one piece of wrought iron, to which the tires are mechanically fixed. Such a wrought iron wheel tends greatly to preserve the axle, as every concussion of the tire against the rails, instead of being directly communicated to the axle, is distributed over a series of vibrations in the wrought-iron wheels, and thus reaches the axle with greatly-diminished force; and by making the axle considerably stronger than the ordinary strain upon it requires, the danger of fracture is reduced to a minimum.

New Method of Lubricating Axles.— A novel method of lubricating bearings is also noticed in the French mechanical journals. The bearing is described as being made rather wider than usual, and a small disk is fitted on the shaft, which dips into a reservoir of oil in the base of the hanging carriage or plummer block, and by its revolution raises the oil and distributes it over the bearing. A tight-fitting cap may be made to cover in the whole bearing, and prevent, particularly in public conveyances, the access of dust. Bearings thus lubricated, it is averred, will run for more than a twelvemonth with one supply of oil.

BEAUFUME'S GAS-FLAME FURNACE.

The points of novelty in this new French invention are as follows:

Instead of burning the fuel directly below the boiler, M. Beaufumé first transforms it into gas in a separate apparatus; and then conveys this gas to the boiler, where its complete combustion causes the generation of the steam. This separate apparatus which M. Beaufumé terms a gasifier, consists of a furnace constructed very like that of a locomotive, with a water space substituted for the tube-plate. Coal is heaped upon the fire-bars to a considerable height, say twenty to twenty-eight inches, according to the quality of the coal. The air necessary for the gasification is supplied in suitable quantities below the fire bars by means of a blowing fan. The oxygen of the air supplied causes very active combustion amongst the lower layers of coal in contact with the fire bars converting the coal into carbonic acid gas; and this gas, in passing through and amongst the upper layers which ought always to remain black, becomes converted into carbonic oxide, and accumulates in the upper part of the furnace, mixed with nitrogen and doubtless hydrogen also. These gases, the temperature of which is but slightly elevated, are conducted to the boiler through a wrought iron pipe, and enter the boiler furnace, after having been thoroughly mixed in a chamber termed the *burner*, with a suitable proportion of air supplied by the blowing-fan. After having been once ignited in the boiler furnace, the gases continue to burn as fast as they are supplied. The flames produced act on the heating surface of the boiler; and the gases remaining after combustion pass through the flues and escape into the atmosphere under the pressure due to the blowing-fan, no chimney being required.

The gasifier, in consequence of the water-space with which it is surrounded, is itself a small boiler, the water in it absorbing the heat developed in the gasifying process, and utilizing it by forming a considerable quantity of steam, which is added to that of the large boiler. The furnace of the gasifier is supplied with fuel through a passage in the top of the apparatus, this passage crossing the steam space and opening into the furnace, whilst it is fitted with doors or valves at both extremities, so that the fuel can be introduced into the furnace without opening a communication with the atmosphere.

A few simple and inexpensive alterations require to be made in the brickwork setting of ordinary boilers, in order to adapt them to being heated by gas. The fire bars being removed, a brickwork platform is constructed in their place, and on this platform a number of brickwork passages are formed,

with openings arranged to allow a portion of the ignited gases to come directly into contact with the boiler surface. These passages are quite indispensable, and form what may be called a heat-regulator. They heat the gases which, arriving in too cold a state, would not be completely burnt did they not come in contact with highly-heated surfaces before being ignited.

The benefits which M. Beaufumé proposes to obtain by means of the system, the principal feature of which we have described, are a very active and complete combustion, without an excessive supply of air, and always regular, a complete consumption of smoke, and, finally, a very considerable saving of fuel.

The labor of the firemen attending to the apparatus consists in raising the fuel to a platform, on a level with the charging passage, and in introducing it through this passage, after ascertaining the height of the fuel inside by means of a rod. From time to time he must poke up the black coals lying above the incandescent mass, to prevent their arching over, so as to form a hollow; he must examine how the gases burn in the boiler furnace, regulate the speed of the blowing-fan, and adjust the registers upon the various air and gas pipes; he must attend to the water supply of the large boiler, and also to that of the gasifier boiler, if the water in the two does not communicate; and, finally, he must clean the fire bars of the gasifier more or less frequenty during the day, according to the quality of the fuel employed, English coal requiring this operation twice in the day — at mid-day and in the evening.

The Beaufumé apparatus requires more attention, and gives, perhaps, a little more trouble than an ordinary boiler; still an ordinary fireman is quite capable of attending to it.

When the boiler and gasifier are cold; that is, when the fire has been extinguished for more than twelve hours, — it requires considerably more time to get up the steam than with the ordinary furnace; for it is at first necessary to work the furnace of the gasifier like an ordinary furnace to get up steam of the pressure of two atmospheres, and this requires about twenty-five minutes. Before that it is not possible to set the blowing-fan in motion, nor to produce gas capable of being burnt under the large boiler. This is one of the inconveniences, attending the Beaufumé apparatus; but, at the same time, when the fire in the gasifier can be kept in during the intervals between working hours, as M. Beaufumé proposes, this inconvenience does not exist with a boiler working every day, and in which steam is kept up during the night, so that the donkey-engine can be started the first thing on the following morning; so that it is only on a Monday morning that fifteen or twenty minutes more is required to get up steam.

The Beaufumé apparatus has also another inconvenience, which is felt every time the fuel is stirred. This operation necessitates the opening of small apertures for the introduction of the poker, permitting large quantities of carbonic oxide to escape, the presence of which in the boiler-house is injurious to the fireman, unless the atmosphere is renewed with sufficient rapidity.

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Finally, that nothing may be omitted, we must mention certain trifling accidents which are apt to occur with the Beaufumé apparatus. These are miniature explosions which take place on igniting the gases in the boiler furnace, when the precaution is not taken of shutting off the supply of air until the moment when the light is applied, and when in consequence the furnace and flues are filled with carbonic oxide, mixed with air. There is, however, not the slightest danger attending these explosions, for the flames do not reach far on account of the very slightly-elevated temperature of the gases.

A commission of the French government, appointed to examine and report on the new apparatus during the past year, presented the following summary:

M. Beaufumé's heating apparatus works with perfect regularity; is quite free from smoke, and effects a great saving. The saving derived from it as compared with the ordinary system of heating, reached as much as thirty-eight per cent. in our experiments, and there is no doubt that the very great saving of one third may be reckoned upon with certainty.

There are no difficulties in working the apparatus; it requires but a little extra care and attention, but not so much as to constitute a matter of serious consideration.

It has the advantage, above all, of being able to use economically fuel of a kind which can only be burnt in ordinary furnaces with great difficulty, such as small coal.

It has the inconvenience of throwing a quantity of carbonic oxide into the boiler house, and, although this is not of much importance on land, it might be serious on board ship. This defect is less, the less frequently the fuel is stirred up, and, with some coals, it scarcely exists, as they do not require stirring up. We must also remark, that, although M. Beaufumé's apparatus has reached a practicable state, it is still too recent an invention to be incapable of improvement, and M. Beaufumé hopes, and we believe it quite possible, to remove the defect in question altogether.

STEAM AND FIRE REGULATORS.

Steam and fire regulators much resemble a safety valve. They consist of a long lever, to which a weight is attached. This lever is acted upon near its fulcrum by a large valve placed under it, which may rise and fall a small distance without letting steam out, as is the case for a piston in a cylinder. The end of the lever is united by a slender rod to the crank of a damper, or of a valve in the chimney. When the pressure of steam increases in the boiler, the valve rises, the lever does the same, and closes the damper; when the pressure decreases, the valve comes down and opens the damper. The weight on the lever is movable, and may be adjusted for any degree of pressure.

At the recent exhibition of the American Institute, in New York, an unusual number of these contrivances were exhibited, the principal of which we shall briefly describe.

In an old invention of Timothy Clark, the valve is an elastic vessel, inclosed in a cylindrical casing, on which is the fulcrum of the lever. Over the elastic vessel is a cylindrical plate, with a projecting pin on top, that rests against the lever one inch from the fulcrum. The lever is four feet long. Thus, the motion of the end of the lever is forty-eight times that of the valve. The elastic vessel is composed of a series of annular plates, soldered to each other at their inner and outer edges; they are made of brass, thin enough to be elastic. This vessel is soldered on the end of a steam-pipe, and no packing of joints is required. If the solder used is not too soft, this valve may last for years without any attention.

In a regulator, exhibited by W. S. Gale, the valve is a circular disc of India-rubber, protected by a similar disc of brass, which has been cut in numerous strips, radiating from the centre, and is thus made yielding. Such a valve cannot play much, and this deficiency is corrected by using two levers, the one above the other; the total increase of motion being ninety.

The valve of Patrick Clark, exhibited by the Patent Steam and Fire Regulator Company, is also a disc of India-rubber, but not a flat one; it has the shape of a half sphere, with flanges around. A cylindrical envelop is screwed over the rubber against a plate, but the lower portion of this casing against which the rubber rests, has, like it, a spherical shape. A piston, made convex underneath, is placed in the casing upon the India-rubber disc; this yielding to the weight, the centre portion turns inside, and becomes concave, when the piston moves up and down by steam pressure. The bent in the India-rubber has a kind of wave motion. By this arrangement a long stroke is obtained. The pin between the lever and the piston is a separate piece; it rests on a deep recess in a projection cast on the piston. This projection slides in a box as a guide to insure the straight motion of the piston. The effect of the lever is to increase the motion only fifteen times. This is claimed as a great advantage by the exhibitor, for the reason that the bearings of the valve in the smoke-pipe are rusty, and that to overcome their friction the force corresponding to a short leverage is necessary.

White's Valve is an elastic pipe, a foot long and three inches in diameter, which is placed horizontally in a semi-circular trough; over it is a long square plate, flat at top and convex underneath. The centre of this plate is cast as a bearing for a rod, with a knife-edge, which acts against the lever. The elastic pipe is made of several layers of hemp fabric, made steam-tight with India-rubber. It is closed at each end by means of plugs. The fabric and plugs are pressed together in the boxes of pillow blocks placed at each end. One of these blocks is fast on the bed-plate, and the steam enters through the plug in it. The other block is free to move to and fro as the pipe becomes longer or shorter, by being more or less full of steam. The leverage is one to twenty-four.

The consumption of fuel in a boiler provided with a regulator is ten per cent. less than when without it. This instrument is also a protection against explosion, as when the pressure of steam rises it dampens the fire and thus prevents the pressure from rising higher.

RUGG'S STEAM BOILER WATER GAUGE.

This invention, which is highly commended, is externally a glass tube, two inches in diameter, and eighteen inches long, which may be placed in any part of the building on the same story with the boiler, or on another. A vertical iron pipe, half an inch in diameter, is inside of the glass tube, placed by the side of the boiler; this pipe is prolonged and enters the boiler below and above the water line. In consequence of this arrangement the water takes the same level in the pipe which it has in the boiler, but this pipe being small, the water in it gets comparatively cool, so that any one may easily leave his hand against the pipe below the water level, when the part immediately above it is kept burning hot by the steam constantly condensing inside. The glass tube is placed around the iron pipe, so that its middle corresponds with the proper level of the water; it is closed at both ends, and in communication with a reservoir of water placed above it. When the communication with the reservoir is opened, the water rushes into the glass tube and rises around the iron pipe, but as soon as it reaches the hot portion of the pipe it boils, and the steam thus formed, filling the glass tube, prevents by its own pressure the water from rising higher. This steam condenses slowly into water against the glass, when the water, rising in proportion, comes again in contact with the portion of the pipe which contains steam inside, and furnishes a new supply of steam. The water in the glass is thus kept on exactly the same level with the water in the pipe and that in the boiler. The gauge in the upper story is on a different principle, and is acted upon by the one below. The two gauges are made to communicate by a pipe, and so much water is let in as will fill the pipe and one half of each gauge. Of necessity, when the water gets down in the gauge below, it will rise in the one above, and vice versa. The second gauge is graduated accordingly the reverse of the first. Several arrangements are now in use to ascertain the height of the water in the boiler, but their principle of action necessitates that they be on the same level with the boiler, and, in general, close to it, where only the engineer can see them.

FIRE-PLACE SHUTTERS.

In many of the first-class houses recently erected in England, fire-place shutters are provided, which, when partly drawn down, act as powerful blowers; and, when wholly drawn down, so as to touch the hearthstone, entirely close up the fire-place, and instantly extinguish the combustion of the fuel in the grate, or that of the soot in the chimney, should it accidentally take fire.

ON ARRANGEMENTS FOR THE CONSUMPTION OF SMOKE.

The London Engineer publishes the following proposed new theory of smoke-consumption. This inventor proposes to purify the smoke by water in its passage from the furnaces to the chimney; in other words, to wash out a large portion of the obnoxious elements of the smoke. His theory is

founded on the observation, that, during wet weather, the rain as it descends carries with it the sooty particles of the smoke ejected by chimneys, the humidity of the atmosphere causing the particles to cohere, and ultimately to fall, partly by their own weight, and partly by their imbibing a portion of the water with which the air is impregnated. The farther the body of smoke recedes from the chimney, the more it becomes cleared, or washed, of these particles.

He proposes to effect this cleansing process by means of the same agent, namely, water, before the smoke shall ascend the chimney; and the *modus operandi* is as follows: To introduce into the main flue behind the boiler, where such an arrangement exists, or at a convenient height in the chimney stalk, where no such flue is used, a jet of water, say the spare water hot from the engine. This jet to be allowed to fall upon the blades of a fan made to revolve rapidly and break the water completely into a fine spray or dense mist, filling entirely — for yards in length, or height, as the case may require — the chamber through which the smoke must pass as it rushes from the furnace. By this process of washing, every particle of soot would imbibe moisture sufficient to cause it to descend to the bottom, and there be carried off by a small aperture. Others of the component parts of the smoke would undergo a chemical change by its passage through the broken water, which would hold them in suspension or solution, and carry them off by the drain. The objection which would naturally be started, on a superficial glance at the proposal, that the introduction of such machinery into the flue or chimney would lessen the draught and impede the progress of the smoke, might be met by the fact that the water introduced, being hot, would not lower the temperature, while the motion of the fan, the blades of which should be formed on the principle of the screw propeller, with the front of the screw turned in the direction of the furnace, would really accelerate rather than retard the draught. The jet of water coming in contact again and again with the blades of the screw would also, by this form of fan, be reduced to a spray of the requisite consistency.

An apparatus for the consumption of smoke, patented by Mr. Woodcock, of London, consists in the admission of heated air, to promote combustion, at a point where an inverted bridge forces the unconsumed smoke down upon the red fire. The smoke is thus brought into contact with the fire, and supplied with the requisite amount of oxygen, in a heated state, to facilitate its combustion. The precise arrangement varies with the length of the boiler and other circumstances, sometimes an extra inverted bridge, iron plate affixed to the top of the flue, being attached. The heated air is introduced through a sort of hollow bridge, the front of which is of brick, and the back of perforated plate iron. The supply reaches it either under the furnace, in the ordinary way, or through a tube on either side of the furnace.

In some experiments recently made at Manchester, England, with this apparatus, the steam in the boiler was allowed to subside considerably below the ordinary pressure, in order that the fires might be supplied with coal more freely, and also to show whether, and in what proportion, an increase of steam could be generated. When the steam was reduced to thirty pounds

pressure, coals were applied liberally, and in seven minutes the steam gauge indicated thirty-five pounds, the smoke during this period being simply of a vaporous transparent character. There were two sixty-horse boilers in use, each having two flues and furnaces. The usual plan was to coal the furnaces under each boiler alternately, but in this instance it was done simultaneously, yet the smoke was so trivial that the observers expressed themselves fully satisfied with the result. In the second trial the steam was raised to a high pressure more rapidly, the smoke still being suppressed. Sawdust and other materials were also thrown upon the furnace, and dense smoke produced, but it was so effectually consumed behind the perforated bridge that the top of the chimney scarcely indicated the existence of a fire.

REQUISITES FOR A PERFECT HOT AIR FURNACE.

The Committee of the Boston Mechanics Association appointed to report on the hot air furnaces exhibited at the last Fair, call attention in their Report to the fact, that all the arrangements for the warming of dwellings, lately brought forward, present no important deviation from the stereotyped ideas which have continued for many years to guide inventors in this branch of construction. Such a result, however, say the Committee, can hardly be regarded as surprising, or as discreditable to the inventive genius of those who have occupied themselves with the subject, when it is remembered that there are few problems in practical science involving such various and complex conditions as that of producing a warming apparatus which shall be at once efficient, economical, and healthful in its operation. The inherent difficulties of this problem will be best illustrated by a brief summary of the functions and requisites of a perfect hot air furnace.

1st. To secure the efficiency and economy of such a furnace, two things are necessary.

First, The fuel employed should be as completely as possible consumed in the body of the apparatus, leaving little or none to escape, in the form of combustible gas, or smoke, or to remain behind in the vitrified condition of clinker. A combustion thus complete can only be attained through a nice adjustment and distribution of the draft, and such form and adaptation of the stove chamber and contiguous cavities as will detain the evolved combustible gas until it shall be entirely burned.

The fire pot should not be a focus of intense heat, but the heat generated in it should be rapidly conducted and radiated from it. In the general adaptation, a regular combustion of an adequate quantity of fuel should be provided for, and the regulation of the consumption ought to depend on the proportion of air admitted to sustain it. It is a very common impression that smoke-consuming furnaces and close air stoves are economical in the consumption of fuel, as the escaping products have a low temperature. A careful examination of the amount of surface will teach any one that this, with the advantage arising from retarded draft, sufficiently accounts for the fact that under the production of really *less* heat, more warmth is radiated. The close stoves in fact distil the fuel, or allow of only an imperfect com-

bustion, by which more than one half the heating effect is lost, and gases dangerous to health are accumulated and escape into the apartment.

Second. The heat evolved in the air chamber and its connections, should with the least possible loss be transmitted to the air of the apartment or building which it is the design of the furnace to warm. To attain this end through the medium of the air chamber, it is necessary to have regard to the extent and form, and radiating as well as conducting character of the surface of the stove, to the mode of entrance and distribution of the inflowing air, and to the prevention, as far as possible, of the escape of heat through the walls of the air chamber itself.

2d. To secure the *healthful operation* of such a furnace, three principal conditions are to be observed.

First. The gases produced by combustion of the fuel must not be suffered to mingle, even in minute proportions, with the air which is to be inhaled. Of these the most noxious are the carbonic oxide and sulphurous acid gases. The former, when the action of the furnace is perfect, undergoes a further combustion, converting it into carbonic acid — a less noxious product; but the latter, or sulphurous gas, is entirely incombustible. It is evolved in considerable quantity from even the purest varieties of anthracite, is especially prone to escape, and is eminently deleterious when breathed habitually, even in small amount. To guard against such a result, the stove must be constructed with as few junctures as possible; and these must be so formed and so connected as to remain air tight, in spite of the warping, and the alternate expansion and contraction of the materials due to changing temperature.

Second. The air of the air chamber must be warmed evenly and adequately, without bringing it into contact with surfaces so highly heated as to cause the organic matters contained in it to be burned or otherwise chemically altered. In order to fulfil this condition, the arrangement must be such as to present to the included passing air a large warming surface heated to a moderate temperature.

Third. The air, in being supplied with an increase of heat in the air chamber, must also be supplied with a *corresponding increase of moisture.* This is requisite to maintain its natural degree of humidity, or that appropriate to the temperature, without which it is felt to be unpleasantly dry, and when habitually breathed, proves highly detrimental, and even ruinous, to the health.

Such are the leading requisites of a perfect hot air furnace; and to unite them all in one and the same construction, is the difficult, and, as yet, unattained result, to which the ingenuity and science of our inventive mechanics ought to be earnestly directed.

IMPROVEMENTS IN FURNACES AND HEATERS.

Reverberatory Furnaces. — An interesting paper on this subject was recently read by C. W. Siemens, of London, famed for his speculations on the economy of heat, before the Manchester (Eng.) Institution of Mechanical Engineers. The subject, as given in a brief report, was a new construction

of furnace, particularly applicable where intense heat is required. The furnace, as at present constructed, is applied to the melting of metals. A number of zigzag passages are formed of fire-brick. There are two fires, and the draught to and from each passes alternately along these passages. So nearly is the heat absorbed that what ultimately escapes up the chimney is only at about 200 to 300 degrees Fahrenheit. It had been used for about three months in a furnace for iron and steel, and the result showed a saving of seventy-nine per cent. as compared with the old furnace, turning out the same quantity of metal. Mr. Atkinson, of Sheffield, observed that they had one of those furnaces, and found the consumption to be so small that he had the particulars noted during six days, of twenty-four hours per day; the consumption was one ton, ten hundred weight, while the consumption for the same period by the old furnace was seven tons; each furnace doing the same description of work. The furnace had been applied to the melting of caststeel with favorable results. The average of melting steel was generally five tons of coal to one ton of steel, but with this furnace they melted a ton of steel with a ton of coal. Besides this, there was no smoke whatever; and if this furnace became general in Sheffield, of which he had no doubt, they would be in a position to vie with any atmosphere in the world. In answer to a question as to whether the changing of the currents in the regenerator — thus letting in cold air upon them after they had become highly heated — did not damage the brick-work? Mr. Siemans explained that in case the cold air came first against the part less heated, then against the next, taking up one hundred or two hundred degrees at each stage, and on this account no cracking from contraction took place. It was also inquired how the iron could be improved by this plan? Mr. Siemans replied that the puddling had not been long tried, but he thought it might arise in this way: In the ordinary furnace there was a violent draught, but in this the draught was small, and the flame did not cut the iron; it gave an intense heat, with a comparative quiet atmosphere, thus less oxide of iron was produced. The iron must also be more pure, because fewer particles were carried over to it from the fire.

Leed's Hydraulic Heater. — The main feature of this invention is the casting, in one piece, of several parallel pipes, in a straight row, with square flanges at each end. The four sides of the common flanges are planed so that, to build up a tubular boiler, it is simply necessary to put the several sets of parallel pipes one above the other, to insert a piece of oil paper between the flanges to perfect the joint, and to press the whole tight by a few bolts. The water reservoir, containing the pipes, is closed by bolting against the flanges of the pipes a top, a bottom, and two sides. The pipes are hexagonal, this being the best geometrical form to bring the pipes of one row under the intervals of the one immediately above, so as to occupy the smallest possible space. The bottom and the sides of the water reservoir are corrugated hexagonally, so as to correspond with the intervals between the pipes, and produce a larger heating surface. The boiler is inclosed in brick work over a fire grate. The flames pass under the bottom, and if this is not sufficient are made to return along the sides, and so heat the water contained

between the pipes. The air in the pipes is warmed; this creates a draft, and new air from the outside is drawn in to be poured into the rooms. The boiler is connected with a small reservoir, in which is a float acting on a lock, making it self-feeding. Each hexagonal pipe is intersected by thin plates of iron, which absorb the radiating heat emitted from each side of the pipe, and from which it is taken by the air. It is alleged by the patentee that these thin plates increase the heating power in an almost incredible proportion. Thus he found that the longitudinal partitions being in the pipes the air came out at 125 degrees, and with the strong draft, the partition being withdrawn, the draft was reduced and the temperature was only ninety-five degrees. Another good effect results from inclining the boiler in the brick work, so that the flames have a slightly downward motion; it is believed that this position facilitates the current of water constantly at work inside, to bring the coldest water against the bottom, when that which has just been heated rises, by reason of its diminished specific gravity.

ON THE FRACTURE OF IRON.

At a recent meeting of the Society of Civil Engineers, London, it was stated, that a large anchor, which had been in store for more than a century at Woolwich Dock, and was supposed to be made of extremely good iron, had been recently tested as an experiment, and had broken instantly with a comparatively small strain, the fracture presenting large crystals. In this case, the effect was believed to be produced by magnetic influences dependent on the length of time the iron had been in the same position.

On the Change of Position among the Particles of Solid Metals, induced by the Action of Gentle but Continued Percussion of the Masses they form.

The following paper by Dr. A. A. Hayes, on the above subject, has been recently presented to the American Academy.

The change by which malleable iron becomes converted into a highly crystalline metal, when subjected to pressure attended by a tremulous motion, as in the case of railway bars, has been often observed, and the attendant circumstances noted. My attention has been called to many cases, in which the same effects have followed a gentle percussive action on a part of a bar, the metal becoming changed at one point only, and hence — by chemical dissection the bar being laid open — the fibrous metal could be seen united to that changed portion, which had become highly crystalline and generally brittle.

"It is well known that the crystalline condition, assumed after the iron has been laminated to the extent of rendering it uniformly fibrous, is due to motion and change of place between the molecules of the iron, without the condition of softening or fluidity. The extreme cases often present us with a polarized condition, in which the crystallized iron is as perfect indeed as would have resulted from cooling a fluid mass in a state of repose.

"Malleable iron in its fibrous arrangement may be assumed as exhibiting its particles of broken-down crystals in a state of tension, in which certain physical conditions, such as specific gravity and resistance to strain,

are insured while this state continues. A return to the moral or crystalline state requires only vibratory motion, in aid of natural polarizing forces always acting, to cause molecules to unite into regular solids and pass to a condition of repose, in which the masses become brittle. It is among the triumphs of modern science that a successful effort has been made to overcome the practical disadvantages arising from this disposition in malleable iron to become brittle; and in one of its most important applications — that of rail-way axles — this has been effected completely. The discovery by E. M. Connel, an English engineer, that the vibrations among the particles of *hollow masses* do not result in crystalline arrangements, has led to the adoption of hollow axles, in which uniformity of thickness of metal is insured, while only two thirds of the weight of the metal used for forming a solid axle is retained.

"An interesting case of the formation of large crystals under quite new conditions, in an alloy of which zinc forms the larger part, has recently been observed by me. This alloy, when rapidly cooled, presents a crystalline arrangement much like that of steel. When cast in the form of balls, in cold metallic moulds, it shows the effect of *chilling* remarkably. The metal forming the exterior becomes solid and more dense, while that in the interior conforming to it leaves a void of a spherical form, in each ball of an inch in diameter as large as a small pea. From well-known facts, we should have expected to find this cavity bounded by crystals or crystalline facets, which does not occur; but its inner surface always exhibits the flaws and irregularities observed when a metallic mass contracts in cooling from a fluid state. These balls were used for reducing saline bodies to powder in revolving cylinders containing several hundreds of them, and the conditions were such that the balls, impinging on each other at mere points as it were, received light blows over every part of their surfaces. It would perhaps be inferred that the diameters would have been reduced by the metal being forced into the void space as the effect of percussion. Instead of this reduction, the balls first become elongated pear-shaped, they then exhibited protuberances, and finally an elongated mammillary form, in which the diameter was one half longer than that of the original, while the whole bulk was increased from one to one and twenty-four hundredths.

"A careful examination of the surfaces showed that the uniformity of the indentations from impinging was constant, and the conclusion was, that the new forms assumed were in no wise affected by any inequality of this action.

"On breaking the specimens, the internal structure of each ball was nearly the same, *exhibiting an effort to form prismatic crystals radiating from a centre on one side of the void, while every particle seemed to have changed its place and made a new aggregation.* Where before the texture was small-granular, broad and brilliant-bladed crystals were found, with open interstices, while in the space originally void the terminal points of many crystals made it a geode in appearance.

"In offering an explanation of this extensive change among the mole-

cules, I think we may consider the polarized state of the outer surface of the ball suddenly cooled as continuous in its action. The attraction of the interior molecules for this part is seen in the formation of a void space; and when the vibrations of impinging points induced a movement, the molecules united their dissimilar poles in the ordinary way of building up a crystalline aggregate. The natural crystal of this alloy being prismatic, room for the radiations which this form must exhibit would be found only by an enlargement of the exterior crust, which owing to the slight degree of malleability in this case, occurred without fracture. Unequal aggregation of crystals formed would produce the concretionary and mammillary masses into which the balls were converted; and it seems probable that the taking on of this form was but one step in passing to one still more simple, in which the natural crystalline form of the alloy would have been presented in a single crystal."

ON THE STRENGTH OF RAILROAD CAR AXLES.

A thorough test of the strength of railroad materials has recently been made at Detroit, at which the railroad axles made by different manufacturers were submitted to a trial which was not only fair but searching and conclusive. Each axle tested was selected by the manufactures from quantities on sale, and not made especially for the occasion, as is too often the case in such matters, and the process was thorough and conclusive. Each axle was confined on a firm anvil with the end projecting over and unsupported for about twelve inches. In this position a hammer weighing 150 pounds was dropped twelve feet, striking the end of the axle, each one of which was four and a half inches in diameter. Ten blows were struck, then the axle was turned over and the same number of blows given on the opposite side, and so continued until the axle was broken. The following is the result: — E. Corning & Company's axles, made of laggoted bar, iron-hammered, stood 193 blows; Wyandott axles, made from Lake Superior iron, stood fourteen blows; Cleveland axles, made from scrap iron, stood eleven blows; showing a very wide difference in the strength of the different axles.

ON THREAD OR FIBRE GILDING.

The following is an abstract of a paper recently read before the Royal Institution, London, by Mr. F. Bennoch, on the operations of fibre gilding, and upon some new improvements recently effected in this department of art.

The author first described the mode of manufacture adopted in India, in the city of Pactun, situated on the river Godavery, famed for its manufactures in gold and silver tissues.

The long shawls which are thrown over the shoulders of the native princes on state occasions frequently cost as much as £300 each. The weft is composed of very fine cotten-thread, generally scarlet or green, the warp being of silk of a similar color. The shawls are formed of long strips of about an inch in width, and placed alternately — a strip of

scarlet and a stripe of gold, the ends are of cloth of gold, about a yard in depth, and the whole shawl is surrounded by a rich border of flowers or birds in variegated silks, woven on a gold ground. The process by which this gold thread used in these fabrics is manufactured is as follows : —

A rod of silver, weighing about twenty-two rupees, after having been roughened by a file, is covered with a leaf of the best gold, weighing one, so that gold forms one twenty-third part of the whole metal. The rod of silver having been wetted, the gold leaf is laid on, and pressed with the finger and afterwards rubbed smartly on the thigh. The edges of the gold leaf that come in contact are beaten a little thinner than the body of the leaf, so as to secure, as nearly as possible, uniform thickness. The bar so prepared is heated in a pan of charcoal till it becomes red-hot. It is then taken out and hammered, and rubbed with a piece of wood, and is ready to undergo the first process of being drawn into wire. The rod is, at this time, about the thickness of a man's thumb, and from six to eight inches in length. In the wire-drawer's house there is a pit dug in the floor, about thirty inches deep, containing a rude horizontal wooden cylinder, or beam, turning on pivots. In this cylinder are fixed four handspikes, over one of which is slipped a ring, to which is attached a chain, with a ring at the other end. Through this ring is slipped the head of a pair of pincers, in the jaws of which is placed the end of the gilt bar, which had previously been hammered at one end, so as to ennable it to pass through the hole pierced in a steel plate, through which the bar has to be drawn, and, being drawn, is reduced in diameter, and proportionably increased in length. As the cylinder revolves, the rod of metal lengthens, and winds round the cylinder. To lessen the friction in passing through the holes, the rod is invariably rubbed over with wax. Having passed through the holes in the steel plate, each hole being a degree finer than the other, the wire is coiled up and reheated, or annealed, by which it is softened, or made more malleable. This process of drawing and heating is repeated over and over again, until the wire is reduced to the substance of ordinary whip-cord. The wire is subsequently passed through a steel plate pierced with fifteen or twenty holes of different degrees of fineness. To make the wire pass easily through the finer hole, it is rubbed at the end between two pieces of porcelain, then slipped through the hole — caught with a pair of nippers, and attached to a limb or spoke of the empty reel, which is turned by the hand, and the wire is driven through with perfect ease. This operation is continued and repeated until the wire becomes as fine as the finest hair.

In this state it is too weak to be woven, and must be united with some fibre before it can be worked in the loom. In order that it may readily attach itself to the thread, it becomes necessary that it should be flattened, which is done by beating it with a highly polished steel hammer, on an anvil. Eight or ten wires are flattened at one time. The flattened wire is next passed into the hands of a spinner or plater of gold thread. Few improvements have been made in the system since the manufacture first began, and the greater portion of the inhabitants of Pactun are engaged in its different branches.

In European art, silver is generally the basis of what is called gold thread. The silver in greatest favor with wire-drawers is extracted from lead. The manner in which the silver is separated from the lead is very simple: when the lead is melted and in a perfectly liquid state, it is poured into a vessel not unlike the large filters used by distillers in charging their barrels. The under part is placed over a fire, so as to keep the narrow or funnel portion at a certain degree of temperature. The silver, being of a greater specific gravity than the lead, cools more slowly. The result is, that while the lead is cooling, the silver sinks or falls to the bottom, and while the lead is becoming a solid mass, the silver retains its liquid character, and can be drawn off nearly pure. Of the silver so produced, a certain quantity is weighed — say from 400 to 500 ounces, and placed in a crucible, which is placed in a charcoal fire, and there remains until the metal it contains is of nearly a white heat. When heated as described, it is ready to be poured into the ingot mould. These moulds are best made of iron. The largest mould is in two pieces, kept together by very strong clamps and screws, and when the metal it sufficiently set, the screws are loosened, the mould separates, and the ingot of silver falls easily out. The ingot so cast is about two inches in diameter, and from twenty to twenty-four inches in length. The bar, or ingot, is then placed in a charcoal fire until red-hot, and afterwards well hammered. This beating and hammering continues until the bar is reduced to a size suitable for the first hole or die through which it has to be drawn, and is increased in length from four to five inches, or about twenty per cent. The bar so prepared is pointed, and made to fit the first die through which it has to pass, and laid on the draw-bench with the point slipped through the die. The point is then seized by the jaws of a pair of monster pincers or draw tongues, with short bow arms, at the end of each of which is a hook that slips over a ring attached to the end of a strong chain cable, drawn by a steam-engine exerting the power of sixteen horses. The greater the draught the tighter the grip, and the ingot passes through the first die with the greatest ease, and is reduced in diameter, but increased in length from ten to fifteen per cent. This process is repeated ten or twelve times, each time the rod being drawn through a smaller die. As the richness of the wire depends upon the thickness of the gold laid on, and as all the gold leaves are very nearly, if not absolutely, of the same substance, the quality of the wire is regulated by the number of leaves placed one over the other, and these vary from ten to thirty leaves. The bar, when overspread with leaf, is enveloped in paper and tied tightly round with cord, and placed in the centre of a heap of lighted charcoal, where it remains until it assumes a bright-red heat: after being burnished, and when quite smooth, it is permitted to cool gradually.

When quite cool, the surface is covered with wax, and then commences the more rapid reduction of size by drawing the bar through graduated steel dies, highly polished: after which it is heated and drawn through a hole, which removes all wax and dirt from the surface.

The steel dies are then dispensed with, because, from experience, it was found that the holes were liable to become what wire-drawers call square;

and, until within a comparatively recent period, the ounce of metal could not be drawn into more than nine hundred or one thousand yards.

The author said that one of the firm to which he was indebted was, he believed, the first to suggest the use of a jewelled die. They experienced many difficulties at first; but all were overcome, and a perforated ruby, set in a metallic frame, answered admirably, and enabled the drawer to produce from one ounce of metal, a wire a mile and a quarter long. In connection with this discovery, it is somewhat singular that there are not more than three men in London capable of perforating and setting these ruby dies properly; and one man, who works probably not more than three hours a day on the average, has received from one wire-drawing firm as much as £500 or £600 in a single year, while they only pay from four to five shillings for each die.

So great is the tenacity of even the finest size, that a piece of wire twelve inches long will bear twelve ounces in weight. It is now ready to be flattened preparatory to spinning round the silk. The flattening machine consists of only two rollers for it to pass between, the one being about ten, and the other about four inches in diameter, and about two inches wide, slightly convex on the face. To impress a substance as fine as a hair, and flatten it to twice or treble its original width, requires the nicest possible adaptation of parts. A single pair of rollers costs £120. The metal is of the rarest quality of steel, and the polish higher than the finest glass. At one time these rollers were made in Sheffield, but now they are manufactured in Rhenish Prussia.

The wire so flattened is now wound on small bobbins, which are placed on the edge of circular rings, attached to a bar over a spinning frame. On the front of the frame, twelve inches from the floor, are bobbins of silk, the threads of which ascend and pass through the centre of the ring to which the reel with wire is fixed. The whole is set in motion, and while the thread is being twisted, the ring with the wire revolves round the thread in the opposite direction, and thirty or forty threads are plated at once. In its new form, though only gold is seen, probably nine tenths of its bulk is silk, while of the remaining one tenth, only one-fiftieth part is gold, — so by labor and ingenuity we are put in possession of a gold thread, — of which only one part in five hundred is gold.

Let us glance only for a moment at the labor required to reduce the ingot of silver, weighing 420 ounces, to the finished wire, weighing 360 ounces, sixty ounces having been cut off — not destroyed — in the several processes of pointing, planing, and occasional accidental waste. Allowing ten hours to the day, it would take one man seventy days or ten weeks to reduce by his labor the ingot of silver, weighing 420 ounces, to its finest size. But no one man is equal to the entire duty. The early processes demand the exercise of Titanic powers, while the later pro cesses demand the lightest touch of almost fairy fingers.

There may be some errors in this estimate, arising from imperfect information, but the author believed it would be found sufficiently accurate to enable one to estimate the labor required to make four hundred ounces of

silver, in a bar twenty inches long, stretch over five hundred miles. But as the four hundred ounces of silver is gilt with only eight ounces of gold leaf, each leaf weighing eighteen grains, and four inches square, it follows that only one-fiftieth part of the wire is gold. So eight ounces of gold in combination with silver, is made to stretch five hundred miles, or over sixty miles for a single ounce. As, from first to last, the wire passes through one hundred to one hundred and twenty dies, it follows that the ingot in its course traverses over fifty thousand miles, or twice the circumference of the globe.

In London, he believed that five hundred ounces of metal could be drawn into wire, while fifty are drawn at Pactun. In London it can be drawn 2,000 or even 2,200 yards to the ounce, while in Pactun they stop short of 1,000, or 1,200.

For many years chemists have attempted every known method of gilding, in the hope of discovering some process by which silk, or other fibre, could be gilded without applying the immense labor, seen to be necessary, before a thread with a covering of gold can be used with facility in the loom, and woven into cloth; but they always failed. In France, where scientific research is liberally promoted by the government, a large reward was offered for a successful plan, but no man ever had the opportunity or satisfaction of claiming it. The electro process gave a fresh impulse to scientific men.

The difficulties of the first stage were soon overcome, and gold was compelled to attach itself to the surface of the thread. A new difficulty arose — the thread, being completely soaked, was long in drying, and when dried, had lost its lustre; while the foundation on which the gold rested was so soft and flimsy, that to burnish it was impossible. Among the several investigators was Mr. Albert Hock, who, failing to find in chemistry the principle by which fibres could be gilded, succeeded by means of a simple mechanical contrivance.

The author said he had felt how difficult it was to find words calculated to explain the simplest mechanical movement, and then the difficulty increased a hundred fold. In the first place, it is essential that the silk used should be of a superior quality, free from knotty nibs and rough places. The gum must be boiled out of the silk, and then the silk tinged to the shade of a light orange; it is then wound on bobbins, the bobbins are placed on a wire, on which they revolve when gently pulled. The end of the thread is passed over a wire, and then under a roller, which works in a trough containing a glutinous but transparent liquid. It then passes over a reel attached to an endless screw or threaded spindle, so arranged that it lays on a brass cylinder, the thread of silk as close as cords are wound round the handle of a whip, without overlapping, until the cylinder is completely covered with the silk, when the thread is broken; the length of the skein of thread depends therefore, upon the size of the cylinder and fineness of the thread, but the cylinder cannot be increased beyond a certain size, and that size must not be larger than can be spanned by a single leaf of gold, and the gold-beaters will not produce it larger than three and three-eighths of an inch square. The cylin-

der being covered with silk in a gummy state, the book with the gold leaf is opened and laid on the palm of the hand; the machine — something like a turning lathe — is moved; the edge of the leaf is made to touch the gum silk, and it is quickly drawn round the cylinder covering the silk. This is repeated until the entire surface of the roller is covered with gold leaf. A piece of cloth or washed leather is fastened on a slip of wood, something like a razor-strop. The roller is turned round and the strop pressed firmly upon the leaf, which not only presses the leaf closer to the silk, but separates the leaf between each of the windings of the finest thread. Thus one side of the finest thread is gilded. It is thus apparent that if gold and green, or any other color, is desired in combination with gold, we have only, first, to dye the thread the color we require, and then, by gilding one side, we secure the combination wished. To gild the entire thread we have only to wind the half-gilded thread on to another roller. The gilded side of the silk thread necessarily winds next to the brass on the second roller, leaving the ungilt part of the thread exposed, and ready to be treated in the same manner as before described, and so the process is completed. It is then wound on to reels of the usual size, and permitted to dry thoroughly. The color by this process is very beautiful, being the natural color of the gold leaf. The great advantage of this over every other thread is its lightness and perfect flexibility, for it can be wound and woven wherever any other thread can be wound or woven.

As regards cost it is, size for size, considerably dearer than the ordinary gold thread, but as it measures a much greater length for the weight, it virtually becomes, for wearing purposes, very much cheaper.

MACHINE SPINNING.

Machine spinning has now increased to such gigantic dimensions that it forms one, if not the most important department of industrial labor. It is calculated that there are at present in use throughout the world forty millions of spindles used for spinning cotton, eight millions for spinning wool, and three millions for spinning linen, severally divided among the various countries, as follows: — Great Britain, 21,000,000 cotton, 2,470,000 wool, 2,000,000 linen; United States, 6,000,000 cotton, 1,400,000 wool, 15,000 linen; France, 5,500,000 cotton, 850,000 wool, 350,000 linen; Germany and Switzerland, 3,500,000 cotton, 1,640,000 wool, 162,000 linen; Russia, 1,000,000 cotton, 510,000 wool, 50,000 linen; Belgium, 900,000 cotton, 200,000 wool, 150,000 linen; Spain, 800,000 cotton, 18,000 wool, 6,000 linen; Italy, Portugal and the rest of the world, 1,300,000 cotton, 912,000 wool, 264,000 linen. The acknowledged superiority of the spinning machinery generally used in this country, enables us to produce a greater amount of material per spindle than any other, which not only tends to lessen the apparently great disproportion of the number of spindles employed here and in Great Britain, but enables us to compete successfully with them in their home market in the cheaper description of cotton goods. Improvements of great value have been made of late years in the construction and operation of spindles for cotton. One of the most recent is a short spindle to which is

fitted a warve revolving around it. Projecting from the upper end of the warve is a tube, which, entering the base of the bobbin, gives motion to the bobbin in part, the other part being secured by a pin in the base of the bobbin, suited to and entering into a hole in the upper plane of the warve. Motion is communicated to the warve, and thus to the bobbin, in the same way as it is given on a frame of live spindles.

ON THE TORSION OF COTTON FIBRES.

The fibres of cotton, as used in the ordinary manufactures of this country, have a torsion by which, under the microscope, they are readily distinguished from linen and other natural fibrous substances. Mr. Bauer was the first, we believe, who observed and delineated the peculiarities of cotton structure as to the torsion of the fibre. Dr. Ure, in his "Philosophy of Manufactures," gives drawings from Mr. Bauer's observations. Mr. French, of Bolton, England, from some observations recently made, considers that the twist does not exist in the unripened fibre in the pod, but only in the ripe cotton. After the torsion is once effected by the sun or otherwise, it remains through all the operations to which the fibre is subjected. Several practical improvements seem to be suggested by attending to these microscopical peculiarities of structure. For instance, Mr. French suggests, that if the twists in filaments of cotton are in one direction, by continuing this arrangement throughout the process of spinning, a thread of greater tenuity, with more strength and smoothness, may be procured than by the present process, which twists one half of the fibres composing a thread in one direction, and the other half in the reverse direction. By following the natural parallelism of the fibre a degree of elasticity would also be imparted to the yarn, and its fabric be altogether improved.

STATISTICS OF TEXTILE MANUFACTURES OF GREAT BRITAIN.

The number of factories from which schedules were received by the factory inspectors in 1856, amounted to 5,117, against 4,600 in 1850, and 4,217 in 1838. Of these, 2,210 were cotton factories, 1,505 woollen, 525 worsted, 417 flax, and 460 silk. The cotton factories have increased 14·2 per cent., and the silk sixty-six per cent. The woollen trade is becoming concentrated in Yorkshire, and the worsted manufacture is almost exclusively confined to the same county. The flax trade is most vigorous in Ireland. The number of spindles and looms in 1856 was respectively 33,503,580 of the former, and 369,205 of the latter, and the actual horse power given in the returns is 161,435. Power looms have increased from 115,801 (in 1836) to the number already indicated, namely, 369,205. The average value of the cotton goods and yarn exported in the three years, 1853, 1854 and 1855, was, in round numbers, £31,000,000; of woollen and worsted goods and yarn, the average exports for three years amounted to £10,000,000. The number of children employed has decreased considerably in flax and woollen factories, while it has increased in worsted. The total number of children under thirteen years of age employed in all kinds of factories last year

amounted to 46,071; the number of males between thirteen and eighteen to 72,220; the number of females above thirteen to 387,826; and the number of males above eighteen years to 176,400, making a grand aggregate array of 682,497. There were during the half year 1,919 accidents from machinery, and fifty-three not due to machinery.

IMPROVEMENTS IN COTTON SPINNING.

S. C. Lister and J. Warburton, of Yorkshire, England, have recently secured an American patent on some important improvements in the spinning of yarn from cotton while it is in the wet state. They have discovered that yarn may be advantageously spun from cotton in that state, and it will be stronger and finer than when spun dry. The cotton is wetted, after having been properly carded with warm water, and then spun between gutta percha or leather rollers, these allowing only a certain quantity of moisture to be retained.

MACHINE FOR GINNING SEA ISLAND COTTON.

A machine for rapidly ginning Sea Island cotton has been recently invented by Mr. L. S. Chichester, of New York, and is said to fully accomplish the object so long sought to be obtained. It is formed of two rollers, twenty inches long, placed in contact, one above the other. The lower roller, of vulcanized rubber, is three inches in diameter, and gives motion to the upper roller, which is fluted, and made of polished steel one inch and a quarter in diameter. In front of the rollers is an iron plate supported on centres below, extending up nearly to the line of contact of the rollers, terminating at the upper edge in a small bead or ledge, and has a rapid motion toward and from the bight of the rollers. The seed cotton is fed over a table, and is carried between the rollers and thrown off behind by a revolving fan, while the seeds are retained in front and ripped out by the combined action of the vibrating-plate and the steel roller. The machine professes to deliver three hundreds pounds of ginned cotton in a day, without crushing a seed. It can be worked by hand if preferred. It saves the expense and loss by drying, sunning and moting, and yields the fibre in unbroken and perfect condition. The inventor is sanguine that his machine will greatly increase the production of Sea Island cotton, which is at present but 50,000 bags, of three hundred pounds each. Much of the territory suited to its growth is unoccupied for lack of a machine that will do for the fine cottons what Whitney's Gin, when first introduced, did for the short staple.

IMPROVEMENT IN THE PREPARATION OF FLAX FIBRES.

An Irish improvement in the preparation of flax fibres consists in throwing down upon the flax a small quantity of oil, say about an ounce to the pound of flax, which is done by boiling the flax in an alkaline soap ley, washing with water, and then boiling it in water, lightly acidulated with some acid, — acetic acid being, perhaps, the most suitable from its exerting no injurious action upon vegetable fibre. The acid decomposes the soap, the fatty constituent of which is left in the fibre, or, perhaps, a mixture of an

acid soap and a small portion of free oil. These enter into and through every part of the fibre. After this treatment it is washed, and is then found to be soft and silky, its spinning quality being thereby much improved and its value very much increased.

DISCOVERIES RELATIVE TO COINAGE.

At the last session of Congress a joint resolution was passed, authorizing the Secretary of the Treasury to appoint two competent commissioners to inquire into the processes and means claimed to have been discovered by Dr. J. T. Barclay, for preventing the abrasion, counterfeiting and deterioration of the coins of the United States, who are to report to the Department as to the value of the alleged discovery. An appropriation of $2,500 was also made to carry on the experiments at the Philadelphia Mint.

In accordance with this resolution, the Secretary of the Treasury appointed Professors Robert Rogers and Vethake, of Philadelphia, to examine and report upon the plan in question.

The memorialist, in his papers submitted to the Finance Committee of Congress, states "that he discovered many years ago a process, by means of which a portion of the precious metal may be abstracted from gold and silver coin at the cost of a fraction of a cent for every dollar's worth thus withdrawn — the appearance of the coin being so little affected by the operation, that about one-tenth of its value may be abstracted in such a manner that the fraud cannot be readily detected by the unaided senses." The Dr. on ascertaining this process in the course of his chemical experiments, and seeing how dangerous it would prove if generally known, set about finding a process which could prevent reduction in the value of our coin. After a series of experiments, he claims to have "discovered certain means, which, if adopted at the Mint, would materially diminish the liability of subsequent coinage to such fraudulent practices," and has at last matured a process of a remedial nature, to such a degree, that if it does not render the coin absolutely insusceptible of reduction, will at least so far diminish its liability to such a process, that the rate of reduction would be so small, and the risk of detection so great, as virtually to guarantee its immunity.

The memorialist also claims to have discovered a process of mintage by which successful counterfeiting will be rendered impracticable and unremunerative. But what is most worthy of consideration, he claims to have discovered a means by which it is practicable by a certain process of depletion and compensation connected with electro metallurgy, to *abstract one-half* of the precious metal from coin without appreciably diminishing its weight, or in the slightest degree affecting either its impression, appearance or dimensions.

A correspondent of the New York Commercial Advertiser states that the memorialist exhibited to the Secretary of the Treasury, and the Finance Committee, coins which had been subjected to that process, and which it was ascertained by actual experiment, had lost half their current value, but which could not be distinguished from other coin.

ON THE HARDENING OF STEEL.

"There are few things of which it is more difficult to understand the *rationale* than hardening steel; or why the same operation, of heating red hot and plunging into a cold fluid, which hardens steel, should soften copper.

"Some persons will explain everything, whether they understand it or not, and for this also have they found, in their own imaginations, a perfectly satisfactory answer, and cut the difficulty by saying steel is condensed by the operation; but, unfortunately for their theory, the reverse is the fact, and instead of being condensed, it is expanded by hardening, as any one may soon satisfy himself by taking a piece of steel as it leaves the forge or anvil, and fitting it exactly into a gauge, or between two fixed points, and then hardening it; it will then be found that the steel will not now go into the gauge or between the fixed points. Or let him rivet together a piece of steel to a piece of iron, filing the ends of both even, so that they may be exactly the same length, then heat them to a proper heat to harden the steel, and plunge them into water, he will find the expansive force of the steel has nearly torn the rivets out, and that it extends beyond the iron at both ends. Any article may be taken with steel on one surface and iron on the other — such as a joiner's plane-iron in the forged state — flat on both surfaces, and hardened; and the expansion of the steel will cause that side to be convex, and the iron side concave.

"All steel expands in hardening, but that the most which is most highly converted, and in direct proportion to the amount of carbon it received in that process. No other general rule can be given for the heating of steel for hardening than this — that it should in all cases be heated as regular as possible to the lowest temperature at which that particular kind of steel will harden, and as little as possible beyond it, remembering that the more highly converted the steel is, the lower the temperature at which it will harden; and that a small article, such as a pen-knife blade, will harden at a lower temperature than a more bulky one made of the same steel, because the small article is more suddenly cooled. The hardening of very bulky articles, such as the face of an anvil, cannot be effected in the same way as smaller articles, by plunging them into water; for the length of time required in cooling will be almost certain to leave the middle of the face soft, where it is of the most consequence that it should be hard. Where the anvil forge is worked by water-power, they possess the best means of hardening them, which is this: — The anvil properly heated, should be placed in a water tank, face upwards, under a shuttle connected with the mill-dam; the shuttle drawn, and a heavy and continuous stream of water let fall from a height of ten or twelve feet upon the anvil face, which effectually hardens the surface.

"A red hot anvil plunged into water, would, for a time, be surrounded by an atmosphere of steam, which would prevent its direct contact with the cold water, whereby its cooling would be retarded too much to harden the face; and hence the advantage of a continuous stream of cold water.

Hence, also, the necessity of moving about in the water even articles of a pound or two in weight, to remove them away from the steam as it is generated upon their surfaces, and thus promote more rapid cooling.

"It is a good plan to harden hammer-faces, where there is a tub and water-tap conveniently near, by plunging the red-hot hammer, held with the face upwards, into the water, so that a stream from the tap may fall upon its face. The face of hammers and anvils is ground after being hardened, but should never be tempered." —*Orr's Circle of the Sciences.*

HARDENING IRON AND STEEL.

A correspondent of the London Engineer Journal gives the following interesting memoranda, the result of his experience on the hardening of iron and steel: —

"Hardening steel is a very peculiar operation, and is one of the greatest contingencies in the manufacture of articles into which it is transformed. Under the most careful management, I have seen very expensive articles in tools and cutlery rendered perfectly useless through the seeming caprice of the two elements, fire and water; if such articles had been rubbed in prussiate of potash, which gives the metal a sort of liquid case, I think cracking in the water, so common an occurrence with superior articles, would be prevented, particularly if the water used were soft, and by the infusion of a little hot water rendered lukewarm. In hardening iron the very opposite course should be pursued; have the water cold as possible, the harder the better; a little quick lime in it would also be an improvement, and if the iron to be hardened be heated nearly to a white heat, rubbed with or rolled with pulverized prussiate of potash, a steel surface is sure to be obtained. The use of prussiate of potash might be a great improvement to the tools used by miners. Their picks and spades would wear longer if hardened with it in the manner I have described. It must be remembered that it is only the surface of the iron which is affected, and the hardening will not penetrate more extensively than the thickness of ordinary tin plates; but the resistance is so superior to that of iron unhardened, that it would be a great saving in the cost of working-tools. There is another advantage; it would not render the iron brittle, consequently there would not be an increase in breakage, which is of considerable importance to the owners of extensive workings."

From another sourse also, we obtain the following: — When a piece of steel is crooked, or when some portions of it are thicker than others, or the whole is very thick, the ordinary process of hardening in water is impracticable, as the piece would crack or twist. For this reason, when exactness is required in a piece of machinery, it is made of soft steel, though hardened metal would be preferable in most cases. The following process does away with the difficulties just mentioned. Let a vessel be half filled with clear water, half with oil; when the heated piece is blood-red, dip it in the upper layer of oil, and as soon as this ceases to boil let it go to the bottom into the water. This plan gives steel the proper degree of hardness for

dies or pieces of machinery; it is unnecessary to soften it over a fire, as when hardened in water.

ON BELLS AND BELL-FOUNDING.

The following memoranda on bells and bell-founding, is derived from a paper on the above subject read before the Royal Institution of Great Britain, by Mr. Denison, the founder of the bells intended for the clock and peal of the palace of Westminster, London.

The problem we were called upon to solve in making the largest bell, said Mr. D., was, not to produce a bell of any given note, but to make the best bell that can be made of a given weight of fourteen tons, which had been fixed as the intended weight. When I say the best bell that can be made, I mean a combination of the most powerful and most pleasing sound that can be got — not, observe, the deepest sound; for we could get any depth of note we liked out of the given weight, by merely making the bell thinner, larger, and worse, as I shall explain further presently. All that I have to do, therefore, is to describe the observations and experiments which led me to adopt the particular form and composition which have been used for this the largest bell that has ever been cast in England. The result is, undoubtedly, a bell which gives a sound of a different quality and strength from any of the other great bells in England. Of course it is very easy to say, as some persons have said, that we have got a clapper so much larger than usual, in proportion to the bell, that the sound must needs be different. But the reply to that is equally easy; the bell-founders always make the clapper at their own discretion; and in order to make the most they can of their bells, you may be sure they will make the clapper either as large as they dare, with regard to the strength of the bell, or as large as they find it of any use to make it; because there is always a limit, beyond which you can get no more sound from a bell by increasing the clapper. In the Westminster bell we found that we could go on increasing the sound by increasing the clapper up to thirteen cwt., or say twelve cwt., excluding the shank or handle of the clapper, or about one twenty-seventh of the weight of the bell; which is somewhat higher than the proportion found to hold in some of the great continental bells; but two or three times as high as the usual English proportion.

I have said already that you may get any depth of note out of a bell of any weight by making it thin enough. At first, everybody who hears a bell, like that which stood at the west end of the Exhibition of 1851, sounding with twenty-nine cwt. very nearly the same note as our sixteen-ton bell, is ready to pronounce the common form of bell, with a sound-bow of one twelfth or sixteenth of its diameter, a very absurd waste of metal. But did it ever occur to them to consider how far they could hear that twenty-nine cwt. hemispherical bell? It could not be heard as far as a common bell of two or three cwt.; and before you get to any great distance from a bell of that kind, the sound becomes thin and poor, and what we call in bell-founding language, potty. Up to seven or eight inches, these bells do very well for house clocks, to be heard at a little distance; but nothing,

in my opinion, can be worse than the bells of this shape, two or three feet in diameter, which people seem to be so fond of buying for the new fashioned cemeteries: whether from ignorance that they will sound very differently on the top of a chapel and in the bell-founder's shop, or because they think a melancholy and unpleasant sound appropriate, or because they want to buy their noise as cheap as possible, I do not pretend to say. These bells, and thin bells of any shape, bear the same kind of relation to thick ones, as the spiral striking wires of the American clocks bear to the common hemispherical clock bells — *i. e.*, they have a deeper but a weaker sound, and are only fit to be heard very near. A gong is another instrument in which a deep note, and a very loud noise at a small distance, may be got with a small weight of metal; but it is quite unfit for a clock to strike upon, not merely from the character of its sound, but because it can only be roused into full vibration by an accumulation of soft blows. Gongs are made of malleable bell-metal, about four of copper to one of tin, which is malleable when cooled suddenly. The Chinese bells, some of which are very large, may be considered the next approximation towards the established form; for they are (speaking roughly) a prolate hemispheroid, but with the lip thickened; whereby the sound is made higher in pitch but stronger, and better adapted for sounding at a distance when struck with a heavy enough hammer. But still the shape of the Chinese bells is very bad for producing sound of a pleasing quality; and generally it may be said, at least I have thought so ever since I began bell ringing twenty-four years ago, that all bells of which the slant side is not hollowed out considerably, are deficient in musical tone. The Chinese bells are not concave but convex in the slant side.

If you make eight bells, of any shape and material, provided they are all of the same, and their sections exactly similar figures (in the mathematical sense of the word), they will sound the eight notes of the diatonic scale, if all their dimensions are in these proportions — 60, 53⅓, 48, 45, 40, 36, 32, 30; which are merely convenient figures for representing, with only one fraction, the inverse proportions of the times of vibration belonging to the eight notes of the scale. And so, if you want to make a bell, a fifth above a given one, it must be two thirds of the size in every dimension, unless you mean to vary the proportion of thickness to diameter; for the same rule then no longer holds, as a thinner bell will give the same note with a less diameter. The reason is, that, according to the general law of vibrating plates or springs, the time of vibration of similar bells varies as $\frac{\text{thickness}}{(\text{diameter})^2}$. When the bells are also completely similar solids, the thickness itself varies as the diameter, and then the time of vibration may be said simply to vary inversely as the diameter. The weights of bells of similar figures of course vary as the cubes of their diameters, and may be nearly enough represented by these numbers — 216, 152, 110, 91, 64, 46, 33, 27.

The exact tune of a set of bells, as they come out of the moulds, is quite a secondary consideration to their tone or quality of sound, because the notes can be altered a little either way by cutting, but the quality of the tone will

remain the same forever; except that it gets louder for the first two or three years that the bell is used, probably from the particles arranging themselves more completely in a crystalline order under the hammering, as is well known to take place even in wrought iron.

We may now consider the composition of bell-metal. It is so well known to consist generally of from five to three of copper to one of tin, that all the alloys of that kind are technically called bell-metal, whatever purpose they may be used for; just as the softer alloys of eight or ten to one are called gun-metal; and the harder and more brittle alloy of two to one is called speculum-metal. But you may wish to know whether it has been clearly ascertained that there is no other metal or alloy which would answer better, or equally well and cheaper. The only ones that have been suggested are aluminium, either pure or alloyed with copper; cast steel; the iron and tin alloy, called union-metal; and perhaps we may add glass. The first is, of course, out of the question at present, as it is about fifty times as dear as copper, even reckoning by bulk, and much more by weight. I have not heard any large steel bells myself, but I have met with scarcely anybody who has, and does not condemn them as harsh and disagreeable, and having in fact nothing to recommend them except their cheapness. Much the same may be said of the iron and tin alloy, called union-metal. I have seen also some cheap bells, evidently composed chiefly of iron, but I do not know what else, and they are much worse than the union-metal bells. It is hardly necessary to say much of glass, because its brittleness is enough to disqualify it for use in bells: but besides that, the sound is very weak, compared with a bell-metal bell of the same size, or even the same weight, and of course much smaller. There is another metal, which you will probably expect me to notice as a desirable ingredient in bells, that is silver. All that I have to say of it is, that it is a purely poetical and not a chemical ingredient of any known bell-metal; and that there is no foundation whatever for the vulgar notion that it was used in old bells, nor the least reason to believe that it would do any good. I happened to hear of an instance where it had been tried by a gentleman who had put his own silver into the pot at the bell-foundry, some years ago. I wrote to him to inquire about it, and he could not say that he remembered any particular effect. This seemed to me quite enough to settle that question. You may easily see for yourselves that a silver cup makes a rather worse bell than a cast-iron saucepan. Dr. Percy, who had taken great interest in this subject, has cast several other small bells, by way of trying the effect of different alloys, besides the iron and tin just now mentioned. Here is one of iron ninety-five, and antimony five. The effect is not very different from that of iron and tin of the same proportions, and clearly not so good as copper and tin; and I should mention that antimony is generally considered to produce an analogous effect to tin in alloys, but always to the detriment of the metal in point of tenacity and strength. Again, here is a bell of a very singular composition, copper 88·65, and phosphorus 11·35. It makes a very hard compound, and capable of a fine polish, but more brittle than bell-metal, and inferior in sound even to the iron alloys. Copper 90·14, and aluminum 9·86, which

makes the aluminum bear about the same proportion in bulk as the tin usually does, seemed much more promising. The alloy exceeds any bell-metal in strength and toughness, and polishes like gold; and as was mentioned in the lecture here on aluminum last year, it is superior to everything except gold and platinum in its resistance to the tarnishing effects of the air. This alloy would probably be an excellent material for watch wheels, the reeds of organ pipes, and a multitude of other things for which brass is now used — a far weaker and more easily corroded metal, but as yet much cheaper. But for all this, it will not stand for a moment against the old copper and tin alloys for bells; in fact, it is clearly the worst of all that we have yet tried. Here is also a brass model for casting bells, which is of course a brass bell itself, and that is better than the phosphorus and aluminum alloys, though inferior to bell-metal. (These were all exhibited.) So much for the compound metals that have been tried as a substitute for bell-metal. But we have now, through the kindness of M. Deville, of Paris, the opportunity of realizing the anticipation formed from the sonorousness of a bar of alluminum hung by a string, and struck. He has taken great pains in casting a bell of this metal, from a drawing of our Westminster bell, reduced to six inches diameter. He has also turned the surface, which improves the sound of small bells, where the small unevenesses of casting bear a sensible proportion to the thickness of the metal, and in fact has done everything to produce as perfect an aluminum bell as possible, though at its present price it can hardly be regarded as more than a curiosity. But now for the great question of its sound. I am afraid [ringing it] that it must be pronounced to exceed all the others in badness, as much as it does in cost. I cannot say I am much surprised; indeed I did not expect it to be successful as a bell, any more than silver, merely because a bar of it will ring. But it was well worth while to try the experiment and settle it. Still the question remains, what are the best proportions for the copper and tin alloy, which we are now quite sure, in some proportions, will give the strongest, clearest, and best sound possible? They have varied from something less than three to something more than four of copper to one of tin, even disregarding the bad bells of modern times, some of which contain no more than ten per cent. of tin instead of from one fifth to one fourth, and no less than ten per cent. of zinc, lead, and iron adulteration. Without going through the details of the various experiments, it will be sufficient to say that we found by trial, what seemed probable enough before trial, that the best metal for this purpose is that which has the highest specific gravity of all the mixtures of copper and tin. It is clear, however, that the copper now smelted will not carry so much tin as the old copper did without making the alloy too brittle to be safely used. We found that the three to one alloy, even melted twice over, had a conchoidal fracture like glass, and was very much more brittle than twenty-two to seven twice melted, or seven to two once melted; and accordingly, the metal used for the Westminster bells is twenty-two to seven twice melted; or, reducing it for convenience of comparison to a percentage, the tin is 24·1 of the alloy (not of the copper), and the copper 75·86. This twenty-two to seven mixture, or even three and a half to one, which is prob-

ably the best proportion to use for bells made at one melting, is a much "higher" metal, as they call it, than the modern bell-founders, either English or French, generally use. As there is no great difference in the price of the two metals, the reason why they prefer the lower quantity of tin is, that it makes the bells softer, and therefore easier to cut for turning, which is obviously a very insufficient reason. I advise every body who makes a contract for bells, to stipulate that they shall be rejected if they are found on analysis to contain less than twenty-two, or, at any rate, twenty-one per cent. of tin, or more than two per cent. of anything but copper and tin.

Analysis of several Bell-Metals.

	Rouen.	Gisors.	York.	Lincoln.	Westminster.	
			Old Peal.	1610.	Top.	Bottom.
Copper,	71·	72·4	72·76	74·7	75·31	75·07
Tin (with Antimony),	26·	24·2	25·39	23·11	24·37	24·7
Iron,	1 2		·33	.09	·11	.12
Zinc,	1·8	1·		traces		
Lead,		.4	1·77	1·16	traces	traces
Nickel,			.85	.58		
Specific Gravity,	......	......	8·76	8·78	8·847	8·869 8·94

COATING IRON WITH GLASS.

Mr. T. G. Salt, Birmingham, G. B., has patented a method of enamelling cast iron, or coating it with glass, by the use of pounded enamel or glass applied to the surface by means of gum water, or other adhesive matter, and afterwards fused. The surface of the cast iron is first cleaned by turning, filing, scouring, or otherwise; and then is applied a thin coating of gum water or other adhesive solution, by sponging or brushing upon the said surface. While the surface is still damp, the powder described as mixture No. 1, is dusted on the surface. The article is then heated until the powder fuses, when a uniform gray vitreous surface is produced. If a white surface is required, a second coating of the adhesive solution must be given, and the powder described as mixture No. 2, is dusted over it, and the article is again heated until the composition fuses.

Mixture No. 1. — Oxide of lead, 20 lbs.; boracic acid, 20 lbs.; cullet,* 60 lbs.; soda, 3 lbs. 6 ozs.; nitre, 1 lb. 2 ozs.; oxide of manganese, 5 ozs. = 104 lbs. 13 ozs.

Mixture No. 2. — Sand, 25 lbs.; cullet, 30 lbs.; oxide of lead, 50 lbs.; soda, 5¾ lbs.; nitre, 4 lbs. 10 ozs.; white arsenic, 3¾ lbs.; oxide of antimony, 8¾ ozs. = 119 lbs. 10¾ ozs.

These materials are pounded and intimately mixed, and then fused. The result is an enamel, which has to be again pounded, and then used as described.

* *Cullet*, an English term for broken glass.

COATING IRON WITH COPPER.

A patent has recently been granted in England to a Mr. Tytherleigh, for coating iron with copper, which is represented as successful in overcoming the difficulty hitherto experienced in causing the two metals permanently to unite.

The principle of the process adopted under this patent is analogous to that of soldering, the difference being that the granulated metal used in soldering is spread over the surface of the iron, instead of being merely applied to the edges which the workmen desires to unite. Supposing, for example, that it is intended to coat a sheet of iron with brass, the patentee prepares the iron by what is technically called "pickling," or cleansing it. He then spreads evenly over the surface the common brass solder, and over this he spreads a quantity of borax to act as a flux. The sheet so prepared is placed in a furnace heated to the proper degree, and after remaining in the fire for about ten seconds, is withdrawn and permitted to cool, the short space of time mentioned being amply sufficient to ensure the union of the metals. Iron thus coated has been subjected to the severest tests in annealing, rolling and planishing, and has successfully endured them all, the brass being so firmly united to the iron that nothing short of actually filing it down is able to effect a separation. By using a furnace with doors on opposite sides, and by the adoption of proper machinery, sheets of any size may be thus coated, and the process may be successfully performed on both sides of the sheet at the same time. For coating iron nails with brass and copper, the process employed is as follows: The metal is fused in a crucible or other proper vessel, and the flux being added, the articles to be coated are placed in the vessel. This method, which is applicable to the coating of nails and other small articles, affords results equally successful with sheets of flat surfaces.

The advantages of such an invention are obvious. The innumerable articles now made of brass or copper may in future, should this invention be extensively adopted, be made of iron covered with either of those metals. Strength, lightness, and cheapness are amongst the principal advantages derivable from the use of the new material; and in addition, the danger arising from oxidation in the case of iron may be entirely obviated.

COATING ARTICLES OF IRON WITH METALLIC ALLOYS.

An American patent has recently been granted for the above purpose to Joseph Poleux, which consists in preparing iron to receive the coating, by immersing it in concentrated mineral acids. As soon as the articles to be cleansed are immersed in the acid, one, two, or more small pieces of spelter are dropped among them, or the spelter is passed into the acid with the articles. The acid acts at once and rapidly on the spelter, holds in solution what it dissolves, and precipitates a film of it on the minutest portions of the iron surfaces the instant the acid has cleansed them, and this film protects such portions from any further action of the acid while remaining in it. Without the spelter, undiluted acid could not be used without great waste and injury to small or thin articles placed in it. The articles are next

taken out, and, without being washed, dried, or undergoing any other treatment whatever, are passed immediately, though slowly, into the bath of melted alloy that forms the coating. Mr. Poleux employs muriatic, nitric, or sulphuric acid, of the ordinary degrees of concentration in commerce, (namely, muriatic, of 18° Beaume; nitric, 38° Beaume; and sulphuric, 66° Beaume, or thereabouts), without dilution. — *Scientific American.*

PRESERVATIVE PREPARATION FOR COATING METALS.

A preparation for coating metals, highly spoken of in the English Mechanical journals, consists of a composition formed by mixing gutta-percha with common resin, tar, pitch, or asphaltum, and dissolving them in impure benzine, or coal naphtha, or other volatile hydro-carbons obtained from bituminous shales or schists. The method pursued in preparing is to dissolve two pounds of gutta-percha and four pounds of common resin, or tar, or pitch, and one ounce of gum shellac, in four gallons of coal naphtha, these ingredients being placed in a suitable vessel and heated to about one hundred and sixty degrees Fahrenheit, until the solids are completely dissolved. When the composition is applied as a paint, coloring matter is added to give the required tint.

IMPROVED ELASTIC TUBES FOR COUPLINGS.

A method of making elastic tubes suitable for effecting the junctions of pipes exposed to variable temperatures, or of pipes which are otherwise strained or required to bend, as the tube-couplings connecting locomotives with their tenders, hose for fire-engines, etc., has been patented by Mr. James Webster, of Birmingham, England. The improved tubes are composed of brass, copper, or other metal or alloy, and in them a series of corrugations are made in planes perpendicular to the axis of the tube, to give elasticity to the tube, and permit of its flexure within certain limits. Webster prefers to make the corrugations as deep as is compatible with the nature of the metal or alloy of which the tube is made, and so narrow that the shoulders between the corrugations shall touch each other on slight flexure of the tubes. Tubes made according to this invention are elastic, both longitudinally and transversely; that is to say, they are capable of elongation and flexure, within certain limits, without taking a set.

IMPROVEMENT IN THE MANUFACTURE OF MALLEABLE IRON.

Mr. S. Fisher, of Birmingham, England, has patented some improvements in the manufacture of anchors, shafting for mill and engine purposes, axles, cranks, and spindles; and in the furnaces, or muffles, used in those operations. The improvements consist in casting the articles named in malleable iron, and afterwards annealing them in a peculiar kind of muffle. This muffle is built in the requisite shape to suit the article to be annealed, of fire-bricks moulded to a suitable form instead of using an iron muffle, which rapidly burns through. As the fire-brick muffle will last for numerous annealings, the new process will be productive of great economy in the cost of the operations to which it may be applied.

IMPROVED ALLOY FOR TYPE.

The alloy commonly used in the manufacture of printing types is composed of lead, tin, and antimony. The best metal is, however, imperfect, as it is continually deteriorating while in a molten state by the evaporation of the most important element, antimony, which action is taking place during the whole time of the manufacture. In order to prevent this change of quality, Mr. Besley proposes the addition of nickel; copper, metallic cobalt, and bismuth, — the nickel and cobalt being the materials used to give hardness, and the copper being the medium by which these substances are caused to unite with the antimony of the type-metal; while by the introduction of bismuth, which has the well-known property of passing instantly from fusion to fixity, the setting of the alloy is expedited.

SCHEUTZ'S CALCULATING MACHINE.

Specimens of Tables, Calculated, Stereomoulded, and Printed by Machinery (Longman & Co.), is the title of a little publication, issued in London during the past year. Adopting this title as a caption, the London Athenæum publishes the following article:

Some eight years ago, we gave an account of the matter at issue between the government and Mr. Babbage, as to the first of the calculating machines invented by the latter. At that time the patience, energy, and ingenuity of two unknown Swedes, George and Edward Scheutz, father and son, had matured a plan of execution which has at last, by the assistance of the Swedish government, actually produced results. Taking Mr. Babbage's ideas, as explained by Dr. Lardner in the Edinburgh Review for July, 1834, they have made their own details, and by the work of their own heads and hands, have produced the machine, from which the tables before us are calculated, and *stereoglyphed.*

A large part of the scientific world looks very coldly on this invention. They say it is of *no use:* that tables could be constructed for a small part of the money, as many and as good as the machine would ever make. Dr. Young thought, we believe, that a portion of what was to be spent on Mr. Babbage's machine, invested in the funds, would keep computers enough at work to supply the place of the machine. This argument was true enough, after a sort. Mr. Weller, senior, made use of the very same argument in a manner which might have stopped railroads, if it had been duly weighed at the time when Stephenson was laughed at for talking of ten miles an hour, and was obliged to keep sixty miles an hour to himself. What rate could I keep a *coach* at, said the veteran whip, for £100,000 a mile, paid in advance. The event has shown that the argument was wrong: the railroad is what it is, and there is much reason to think that the telegraph would never have been thought of in our day but for the railroad. On with the work, then let every development of thought, and every adaptation of thought, be encouraged and welcomed, even though its ultimate uses — we mean those uses which the man of the day can *see,* — were as distant as gravitation and lunar distances from the conic sections of the Platonic school of geometers,

which were ready to hand when wanted. Those who decry the highest stone because it supports nothing are fortunate in one point, — they will always have something to decry : those who are busy in raising the next stone will find them another job at the very instant the old one is finished. Machinery will do anything which symbolic calculation will do, whether simply numerical or algebraical; and the highest recent developments of algebra seem to point to a time when the details of mere calculation *must* be the work of machinery, if final results are to be actually exhibited.

George Scheutz, the father, took up the subject in 1834, after reading the Edinburgh Review above mentioned. He desisted, after proving the practicability of the idea by some models. In 1837, Edward, the son, took up the plan, and, after a refusal from the government to lend any aid, the two completed a machine of small compass in 1840. This was enlarged, the model of the printing part was added, and the machine was exhibited to the Swedish Academy of Sciences in 1843. On the certificate of this body, the projectors sought for orders (we mean commissions to construct machines) in various countries, but without success. In 1851, after another inspection in the previous year by the Swedish Academy, a new and unsuccessful application was made to the government. A motion for a national recompense in the Diet was more successful; the motion was carried, subject to the condition that the king, after examination, should find the machine complete and successful. But the projectors wanted the recompense to complete the machine; and they obtained it on giving security for its return in case of failure. Fifteen gentlemen ran the risk for the honor of their country. The machine was completed, and performed its work perfectly at the very first trials. But the expenditure had far exceeded the recompense awarded; on which, at the suggestion of the king, the Diet added another sum of the same amount. This was in August, 1854. The inventors immediately brought their machine to England, where it soon excited interest. Mr. Gravatt, the civil engineer, took it up, explained it at the Royal Society, and at the Paris Exhibition. The machine was again brought to England in 1856, and the publication of the present tables was resolved on.

While this was going on, Mr. Rathbone of Albany, at the suggestion of Professor B. A. Gould, purchased the machine for £1,000, and presented it to the Dudley Observatory of that city.

Great Britain, in consideration of nearly £20,000 expended on an attempt, which it would not complete, has the honor of being the ground on which an American merchant bought the machine which the Swedish Government had enabled two of its subjects to make. The idea of finding a purchaser in England seems never to have entered the mind of any one.

In the construction of the machine, many parts of Mr. Babbage's details have been adopted, and many have been altered. The calculating portion of the machine, which appears in the front of the drawing, consists of a series of fifteen upright steel axes, passing down the middle of five horizontal rows of silver-coated numbering rings, fifteen in each row, each ring being supported by, and turning concentrically on its own small brass shelf, having within it a hole rather less than the largest diameter of the ring. Round the

cylindrical surface of each ring are engraved the ordinary numerals from 0 to 9, one of which, in each position of the ring, appears in front, so that the successive numbers shown in any horizontal row of rings may be read from left to right, as in ordinary writing. The upper row exhibits the number or answer resulting from the calculation to fifteen places of figures, the first eight of which the machine stereotypes. The numbers seen on the second row of rings constitute the first order of differences, also to fifteen places of figures, if that number be required; and the third, fourth, and fifth rows of rings, in like manner, exhibit the second, third and fourth orders of differences. Any row can be set by hand, so as to present to the eye any number expressed according to the decimal scale of notation; such as the number 987654321056789, the first eight figures of which, if in the uttermost row, would, on being calculated by the machine, be immediately stereotyped But by simply changing a ring in each of two of the vertical columns, the machine can be made to exhibit and to calculate numbers expressed in the mixed senary system of notation, as in that of degrees, minutes, seconds, and decimals of a second. Thus, for instance, if the result 874324687356402 were indicated in the upper row of rings, it would be stereotyped 87 degrees, 43 minutes, 24·69 seconds. While this process is going on, the argument proper to each result is at the same time also stereotyped in its proper place; nothing more being required for that purpose than to set each row of figure rings to differences previously calculated from the proper formula, and to place a strip of sheet lead on the slide of the printing apparatus; then, by turning the handle (to do which requires no greater power than what is exerted in turning that of a small barrel-organ), the whole table required is calculated and *stereomoulded in the lead*. By this expression is meant that the strip of lead is made into a beautiful stereotype mould, from which any number of sharp stereotype plates can be produced ready for the working of an ordinary printing press. At the average rate of working the machine, 120 lines per hour of arguments and results are calculated and actually stereotyped, ready for the press. It is found on trial that the machine calculates and stereotypes, without chance of error, two-and-a-half pages of figures in the same time that a skilful compositor would take merely to set up the types for one single page.

Our readers will, of course, understand that the machine is not self-acting. It does not give logarithms, for example, merely for saying, Good machine, we want logarithms. It must be fed both with manual power and *with calculation*. The seed must be according to the harvest wanted; men do not grow figs of thistles, even in a calculating machine. But the return is greater than in most harvests; a very little calculation makes the machine do an enormous quantity of result by help of barrel-organ exercise. But how are errors to be avoided if human fallibility is at the bottom of all? It is not a matter of course that *errors* will be avoided; but *casual* errors will be avoided. *All* is right, if the machine is rightly fed; *all* is wrong, if it be wrongly fed. Now, error *throughout* must be detected; labor and lead therefore may be thrown away, but wrong will never be published for right.

The tables consist of a complete five-figure set of logarithms, with the

usual four figures of primitive number; there are some small specimens of other tables. The figures are, as they ought to be, *punchy;* the *justification,* as the printers call it, is perfect. The differences are not printed; the printing part was not carried far enough for this.

Calculation by machinery, with results told by the insentient calculator itself, is now an accomplished fact. It does not excite its proper interest, because the unfinished attempt of the original inventor has been for many years before the world. But the time may come when this first actual success will be quoted as the commencement of a long and singular chain of adaptations.

JONES' SUMMATOR.

This is an instrument designed to perform the addition of numbers. It consists of a circular card, upon which the numerals from one up to one hundred, are printed at the points of intersection of a spiral line with a number of radial lines (on the instruments constructed are one hundred of the latter), the figures increasing in amount as they approach towards the centre of the card. The card is hung by a central pin to and behind a light circular plate of wood, which hides all of it except a portion which is visible through a horizontal slot, extending from the circumference towards the centre. Upon the outer edge of this plate, figures from one to one hundred are printed in legible characters, the tens, twenties, thirties, etc., being connected in groups by strong lines, and printed in dark characters to give greater facilities in finding any desired number. Surrounding the plate is a ring of wood, which is attached to the card, and moves with it around the centre-pin; in its periphery are one hundred indentations, corresponding with the number of the radial lines, and with the figures printed around the edge of the plate. A small index slides in the slot of the plate, its motion being coincident with that of the spiral line on the card over which it always is, approaching to, or receding from the centre, as the card is turned from right to left, or *vice versa.*

The operation of adding is performed thus: — The index is placed at zero by turning the card backwards by means of a crank handle intended for that purpose; the indentation over the figure equalling the amount of the bottom line of the column to be added is brought by the revolution of the ring and card just opposite the slot in the circular plate, at which point it is arrested by a stop, against which the finger or pencil used to rotate the ring strikes, when the index will have moved towards the centre, and will mark the amount of the first line of the column to be added. The amount of the next line being taken, and the ring turned, the number shown by the indicator will equal the amount of the first and second lines, and so on. To those persons who are not expert in adding, and do not care to become so, this instrument will no doubt be useful. It is mounted on a near stand, and is a much more convenient and rapid way of adding mechanically, than the old way of slipping balls upon wires stretched in a frame, and which no doubt is familiar to all.

ON A STANDARD DECIMAL MEASURE OF LENGTH FOR MECHANICAL ENGINEERING WORK.

The following is an abstract of a paper on the above subject, recently read before the Manchester (Eng.) Mechanic's Institution, by Mr. Whitworth. The paper commenced by showing that a general desire is now expressed for some simpler method of measuring and computing than has hitherto been the rule in mechanics and engineering. The fractional system did very well in the old and cumbrous modes pursued by mechanics; but a change to some certain and easy system of measurement and notation was now an absolute necessity. A decimal system was that now proposed by the author for both measurement and notation, the inch being taken as the unit, and divided into thousands. A workman would very soon learn to think in tens, hundreds and thousands, instead of the present mode of computing sizes, thus securing greater safety in all kinds of work which are dependent on accuracy of size, as the manufacture of guns and warlike instruments; and much greater accuracy in all descriptions of work. After showing other advantages to be derived by the general adoption of a decimal system of measure in all engineering and mechanical works and establishments, and proposing that the present measure, or rule of eighths, be abandoned for a rule in thousandths, the paper concluded by showing, from tables exhibited, the nature of the decimal system proposed. Mr. Whitworth then showed several metal specimens of external and internal gauges and sizes, arranged to a nicety, equal to 1-5,000ths of an inch, on the system produced. An interesting discussion followed the reading of the paper, in which several gentlemen took part. Some were for adopting the plan immediately, others for appointing a committee to investigate the matter, or to report upon the best plan of carrying the method into practice. It was ultimately moved by Mr. Fairbairn, and carried unanimously, that the meeting pledged itself to the scale of one inch, and that it should be divided into one thousand parts.

On the Importance of Introducing a New and Uniform Standard of Micrometric Measurement.—In a paper on the above subject, before the British Association, by Prof. Lyons, the author alluded to the great difficulties experienced by observers in enumerating, rendering, and even remembering the various kinds of measures now in use in these countries and on the continent, portions of the English, Irish, and French inch and line, and decimal parts of the French millimètre. The high figure in the denominator and the number of decimal plans were exceedingly cumbrous. He (Dr. Lyons) would propose that some definite micrometric integer should be assumed, being a determinate part of unity. He proposed that this measure should be denominated a microline. He did not mean definitely to bind himself to the adoption of any standard, but would propose provisionally that the one ten-thousandth part of the English inch should be assumed and denominated the standard microline *pro tem.* He would, however, have his hearers bear in mind the present tendency of scientific men towards a decimal system. For his own part he would prefer the French decimal scale.

LEONARD'S DYNAMOMETER.

A new Dynamometer (power measurer) invented by W. B. Leonard, Esq., Secretary of the American Institute, is constructed as follows: A square box of cast iron, to the front and back plates of which are attached links for the appliance of the machine and the power used, contains at the bottom a piece of ordinary clock-work, the object of which is to give a constant revolving motion to a circular table covered with leather. Near the top of the box, on either side of this revolving table, are stiff spiral springs, which are fastened to the front and rear plates of the box. Directly over the revolving table is a spindle, the two parts of which slide upon each other, like a telescope, as the power applied draws out the spiral springs; and in the centre of this spindle is a brass wheel which revolves at right angles with the circular travel of the table. At the extremity of this spindle is a disc, on which revolving hands mark by proper figures the total amount of strain made by the team. Now attach the team to the front link and the machine to the rear one of the box. The parts are drawn asunder, thus straightening out the spiral springs, pulling the sliding portion of the spindle and causing the upper brass wheel to pass off of the centre of the revolving table, where, of course, it previously was at rest, and to revolve itself by the forward travel of the table, which it touches. As this wheel goes round, it turns a pinion wheel at the other end of the spindle, and by an arrangement of one or two cog-wheels the hands go round the disc, faster or slower as more or less power is applied, and a perfectly accurate registry is made of the draught of the machine attached.

EFFECT OF THE DRAINAGE OF THE LAKE OF HAARLEM.

The value of the land recovered by Holland from the lake of Haarlem, is increasing at a rate which insures payment of all the outlay for the drainage in a comparatively short time. Good crops of colza and rye have been grown, and the potatoes are excellent. Two farms of considerable extent are established; two large villages are being built, and the district is traversed by two good roads. No ill consequences were experienced from intermittent fevers, as was dreaded when the surface was first laid bare, and the numbers of dead fish had no other effect than to fertilize the soil. No object of natural history or of antiquity was discovered. Holland has now two or three parishes more than she had four years ago. Leyden and Haarlem disputed possession of the newly won territory; but the government has decided that it shall form a district by itself. Amsterdam, relieved from the danger once threatened by the meer, is laying on a supply of drinkable water from the downs or sand-hills along the sea shore. It is worthy of remark, that the sources in these hills, though copious and of good quality, are most of them below the level of the sea.

DEADENING WALLS AND CEILINGS.

There is no greater nuisance in modern houses than that of the transmission of sound through parti-walls. Any practical, inexpensive, and efficient

means of deadening sound will be a great boon. Solid walls and solid floors transmit sound in the highest degree. Is there no remedy? The late Mr. Cubitt had some trouble at Balmoral with certain floors, and remembered that in taking down an old palace floor (many years before) vast quantities of cockle-shells fell out from betwixt the joists. These had been used in plugging. The idea was acted upon. Cockles were dredged, and brought; the shells were cleaned, and dried, and used, with beneficial effect. The cellular spaces thus produced absorbed sound. Some highly cellular texture may be applied to walls, ceilings, and floors, which shall resist fire and ordinary decay, allow of finish, and yet deaden sound. Who is to invent and introduce such materials? They may patent the invention and make a fortune, if they will only abate the existing nuisance, and enable us to have solid parti-walls and fire-proof floors without being compelled to hear what is going on up stairs and in the next house. — *The Builder*.

ON THE CREMATION OF THE DEAD.

An association of gentlemen has been recently formed in London, who have pledged themselves to sustain the practice of what quaint Sir Thomas Brown aptly called "Hydriotaphia, or Urnburial." These gentlemen set forth that they have been moved to take this singular step by many considerations, of which the most creditable and the most forcible certainly are those which are derived from a reference to the effect upon the public health of the common practice of inhumation.

They allege that the gases which are evolved in the process of decomposition from any considerable "necropolis," or city of the dead, must inevitably affect injuriously the atmosphere of the surrounding region; and since it is not possible that any large proportion of the dead of a great and crowded metropolis should be interred at a great distance from the place of their residence in life — the expense of the transport, and the inconvenience thereby entailed upon surviving relatives, making such transport very burdensome to the mass of the middle classes even, and quite out of the question for the preponderating multitudes of the poor — they insist upon the imperative necessity of such a general change in our manner of dealing with the dead, as shall adequately protect the living.

That our strong feeling in favor of the custom of interment is not founded on any intrinsic instincts of human nature is sufficiently established, say the friends of cremation, by the oscillations of public opinion in regard to this matter through many ages and over many lands; and although we may shrink from the mere suggestion of a change in the established funeral customs of Christendom, we must remember that our sensibilities are, after all, really *educated;* and that no consideration of this sort should restrain us at least from a calm and quiet investigation of the grounds upon which the advocates of a reform in the mode of funeral obsequies advance their startling propositions in favor of consuming in the purifying flames, and preserving in sacred vessels, those precious remains of the loved and lost, which we now consign to the gradual destruction of nature's chemistry.

ART IN NATURE.

The old corals abound in ornamental patterns, which man, unaware of their existence at the time, devised long after for himself. In an article on calico printing, which forms part of a recent history of Lancashire, there are a few of the patterns introduced, backed by the recommendation that they were the most successful ever tried. Of one of these, known as "Lane's Net," there sold a greater number of pieces than of any other pattern ever brought into market. It led to many imitations; and one of the most popular of these answers line for line, save that it is more stiff and rectilinear, to the pattern in a recently-discovered Old Red Sandstone coral, the *Smithia Pengellyi*. The beautifully-arranged lines which so smit the dames of England, that each had to provide herself with a gown of the fabric which they adorned, had been stamped amid the rocks *eons* of ages before. And it must not be forgotten, that all these forms and shades of beauty which once filled all nature, but of which only a few fragments, or a few faded tints, survive, were created, not to gratify man's love of the æsthetic, seeing that man had no existence until long after they had disappeared, but in meet harmony with the tastes and faculties of the Divine Worker, who had, in His wisdom, produced them all. —*Hugh Miller's Testimony of the Rocks.*

EXTINGUISHING FIRES ON SHIPBOARD.

Dr. James Patton, of Paisley, Scotland, has proposed a plan for extinguishing fires on shipboard, by filling the vessel with carbonic acid gas, as soon as the crew and passengers are removed upon deck. This can be accomplished, by placing in some convenient part or parts of the vessel, a tank or tanks, containing super-carbonate of soda, or some other carbonate, and in the interior thereof a glass vessel, containing a due proportion of sulphuric or other acid for displacing the gas. The tank should communicate with the deck by an opening through which an iron rod could be passed, and having openings in the side through which the gas might escape into the hold of the vessel, the upper opening being closed as soon as the glass is broken, so that the gas might be diffused below. Upon any alarm of fire, all being mustered upon deck, the carboy in the interior of the carbonate might then be broken by the iron rod; the vessel would fill in a few minutes with fixed air, extinguishing the fire at the same time, so that there would not be the smallest danger unless it had penetrated the deck previously. The above may be verified, by taking an air-tight deal box, a tumbler, or any convenient air-tight vessel, placing a quantity of super-carbonate of soda at the bottom, with a tube reaching to the top, then, filling the vessel with cotton, or other combustible, ignite, and while combustion is going on, pour a little vinegar or other acid in the tube upon the soda; the fire will instantly be extinguished, even though there is no covering over the vessel to retain the gas.

EXPERIMENTS IN AËROSTATION.

At a recent meeting of the French Academy, Marshal Vaillant gave an account of some trials made at Vincennes in the spring of 1855, under the

direction of the engineer corps of the French army, to ascertain, if it were possible, to maintain a balloon five or six hundred metres above a fortified town, and, if so, to cause incendiary or fulminating balls to fall. Nothing was successful, and the commission, after the expenditure of much money, gave up the project.

FORMATION OF THE CHINESE CONCENTRIC IVORY BALLS.

The Rev. W. C. Milne, in his recent work on China, thus explains the mystery of curved concentric ivory balls, — ten, twelve, or more, cut out, one within the other:

It has long puzzled people how so intricate a piece of workmanship is fabricated. It has been conjectured, that originally they are balls cut into halves, so strongly and nicely gummed or cemented together that it is impossible to detect the junction. And I have seen it deliberately stated, that attempts have been made by some to dissolve the union by soaking and boiling a concentric ball in oil, — of course, to no purpose. The plain solution, obtained by myself from more than one native artist, is the following: A piece of ivory, made perfectly round, has several conical holes worked into it, so that their several apices meet at the centre of the globular mass. The workman then commences to detach the innermost sphere of all. This is done by inserting a tool into each hole, with a point bent and very sharp. That instrument is so arranged as to cut away or scrape the ivory through each hole, at equi-distances from the surface. The implement works away at the bottom of each conical hole successively, until the incisions meet. In this way the innermost ball is separated; and to smooth, carve, and ornament it, its various faces are, one after the other, brought opposite one of the largest holes. The other balls, larger as they near the outer surface, are each cut, wrought and polished precisely in the same manner. The outermost ball of course is done last of all. As for the utensils in this operation, the size of the shaft of the tool, as well as of the bend at its point, depends on the depth of each successive ball from the surface. Such is their mode of carving one of the most delicate and labyrinthic specimens of workmanship to be found in China or elsewhere. These "wheels within wheels" are intended chiefly for sale to foreigners; and numerous specimens annually are sent to England and America.

EXPERIMENTS ON IRON TARGETS.

Some experiments have been made at Woolwich, England, to test the power of resistance of timber lined with four-inch iron plates; the combined materials being of the same thickness as the immense floating batteries constructed during the late war; and also to test the durability and quality of iron plates manufactured by rolling, as compared with iron turned out by the hammer. The target was an immense construction of timber, lined with four-inch plates of iron, of both descriptions, and the total weight was thirty tons. This target was placed on a foundation constructed for the purpose, and twenty-four rounds of 68-pounders were fired, with the following

results: — The first fourteen rounds were fired at a distance of six hundred yards, and, after the first few rounds, the timber work gave way in several directions. The last ten rounds were fired at a distance of four hundred yards, and the work of destruction commenced was thus consummated. The timber work of the target was completely broken and splintered, and the plates of iron made by the rolling process were cut up and split, having apparently but little adhesion. The iron plates which had been made by the old process resisted the solid wrought iron shot much more successfully, and it was apparent that these plates possessed more adhesive power than the rolled plates. Such was the tremendous force of the cannonade that the immense target was forced by the concussion several feet from the foundation or box on which it was placed. The last shot fired was the most effective. This shot went completely through the target, timber-work and iron included. It was the subject of remark by several practical men that the principle of combining timber with iron plates, was, no doubt, the best that could be at present adopted; but it was evident from these experiments that such plates must be improved upon before they could resist the concussion of repeated discharges of heavy shot.

ON THE STRENGTH OF IRON ORDNANCE.

During the past year, some interesting trials of the strength of heavy ordnance, manufactured by Alger, of Boston, for the United States Navy, have been made under the direction of the Department. One of a number of nine-inch calibre iron guns was selected as a sample for undergoing the test required per contract, namely, that they should endure one thousand rounds, of ten pounds of powder, and a projectile of seventy-two pounds.

The result of the trial was, that the gun in question stood 1,500 rounds with so slight an effect that it would probably endure another thousand, and, as the rest of the lot were made of the same iron, and under precisely the same circumstances, they are presumed to be of the same character.

ON THE CONSTRUCTION OF THIRTY-SIX-INCH MORTARS.

At the last meeting of the British Association, Mr. R. Mallett presented a communication on the above subject. The largest shells, said Mr. M., with few exceptions, used during and up to the late war, were thirteen-inch shells, of about 180 or 200 pounds weight, and holding about nine pounds of powder. The depth to which this shell would sink in compacted earth was about thirteen feet, but it was incapable of piercing masonry beyond eighteen or twenty inches, except by repeated shots, and was fired at a range of 4,700 yards. It had occurred to him as very desirable that a shell should be thrown at much greater range with greatly increased power of demolition and penetration; and he came to the conclusion that a shell of less than three feet in diameter would not answer the purpose, and he found that such a shell, holding five hundred pounds of powder, would become not so much an instrument by which human life would be taken, as a mine or series of mines, transferred into fortifications, piercing compacted earth to a depth of fifteen feet, and demolishing solid masonry at many times the distance at

which the small could do. Mr. Mallett then, at considerable length, explained the difficulties which he had encountered and overcome in the construction of the mortars he had completed, capable of firing the above shells, and the capabilities of the latter. It was necessary that a mortar large enough to project such a shell should be constructed in separate pieces, because so large an instrument could not be forged without sustaining flaws in the difficult process of cooling. In his researches and consideration of the subject, he was greatly indebted to Dr. Harte for the able manner in which, with his profound mathematical abilities, he had aided him. He had also considered the general question of the application of wrought iron to artillery, and came to a conclusion which would show the improvement as regards the money part of the question. From a table before the Section on the board, the value of guns of equal weight was mentioned, in bronze, wrought or cast iron, and German steel. A gun of say one ton in cast iron would cost £1 ; in bronze, £10 ; in steel, £2 ; and wrought iron but £15. A gun of wrought iron would be but one fifth the weight of a bronze gun, and therefore about four fifths of its weight was uselessly put upon the horses employed to draw it. Other elements, such as wear and tear, and cost of transport also remained to be considered. Capt. Blakeley observed, that after the explanations of Mr. Mallett, it would be unnecessary to spend time in advocating the utility of monster guns. The objection to them so often mentioned was their unwieldiness, but those who had witnessed the applications of Mr. Armstrong of water-power would perceive that they could easily be moved by that means. The difficulty of constructing large guns on account of the greatly-increased strain to which they were subjected was also an objection; but it was shown that those difficulties could be overcome. His (Capt. Blakeley's) plan of constructing large guns differed very slightly from that of Mr. Mallett. The interior of the gun was made of cast iron, because of its small cost, and placed on it were rings of wrought iron, at a white heat, hammered together. A nine-pounder constructed on this principle had been tested at Woolwich, and 158 rounds were fired, the gun being loaded to the muzzle, and those who conducted the experiment declared that it was the strongest gun they had ever witnessed. Mr. Fairbairn had never seen a more perfect piece of workmanship than Mr. Mallett's very ingenious gun, and it only remained to prove, by actual experiment, whether it would succeed. He was of opinion, after much consideration of the subject, that cast iron of the best quality was the most suitable material for the construction of guns. Mr. Rennie attributed the circumstance that the Russian guns were enabled to fire two or three thousand proof rounds to the fact that they used superior metal in the construction of their cannon. He was inclined to think that cast iron was better than wrought iron, owing to the great difficulty in the forging of wrought iron.

ON THE INTRODUCTION OF HEAVY ORDNANCE INTO THE UNITED STATES NAVY.

The new steam-frigates recently added to the United States Navy have been armed with the new ordnance introduced by Commander Dahlgren,

and consists of nine, ten, and eleven inch shell-guns, of great weight and range. The introduction of these shell-guns to the exclusion of shot, says the Secretary of the Navy, in his last report, was by no means inconsiderately or hastily made. It was suggested by Commander Dahlgren, in 1850, that he could "exercise *a greater amount of ordnance power with a given weight of metal*, and with more safety to those who managed the gun, than any other piece then known *of like weight*."

Commodore Warrington, then at the head of the Bureau of Ordnance, ordered the gun proposed.

The proving and testing continued during the years 1852, 1853 and 1854. The points of endurance and accuracy were specially examined. The first gun stood five hundred rounds with shell and five hundred with shot, without bursting, and subsequently other guns were proved to the extreme, and endured 1,600 and 1,700 rounds without bursting. Shells have been adopted because they are deemed preferable, not because of any apprehension that shot cannot be used in these guns with perfect security, that point being settled by actual experiment. This fact is said to be attributable to the circumstance of there being thrown into the breech a very considerable additional weight of metal. If, therefore, it is at any time contemplated to attack the solid masonry of fortifications several feet in thickness, solid shot can be used, although recent developments in the late European wars will hardly encourage such assaults to be often undertaken.

During the past year the sloop-of-war Plymouth, under the charge of Com. Dahlgren, was ordered to cruise at sea, with a view of testing the efficiency and working of the new ordnance. The battery of the sloop consisted of one pivot-gun, and several nine-inch guns. A recent report, submitted by Com. Dahlgren, states, that when the ship has no inclination, the nine-inch guns can be fired as fast as 32-pounders, but when the deck is inclined, the working of the guns is much retarded; still, even at the inclination of eighteen degrees, a well-drilled crew was able to discharge shells at intervals of sixty-five seconds, and at an angle of five degrees in thirty-five seconds. When the vessel was on an even keel, the large eleven-inch pivot gun could not be fired so rapidly as the nine-inch cannon; but it was worked more rapidly when the deck of the vessel was inclined seven or eight degrees. At this angle, seventeen shells were discharged in the same time as thirteen from the nine-inch guns. As a pivot gun, it was found as manageable as a common sixty-four pounder; and no difficulty was experienced in making such heavy ordnance secure in the most stormy weather.

It is not stated how far these guns carry. The target was placed only at 1,000 yards distance, but they can, undoubtedly, send shells much further. The large eleven-inch gun weighs, with its carriage, no less than twelve and a half tons.

ON THE MANUFACTURE OF SHELLS (BOMBS).

In 1854 the demand for the ordinary cast-iron shells in England having been extremely urgent, many of the more eligible founderies of the kingdom engaged in their manufacture; still, from numerous difficulties which are

almost invariably experienced by a new maker in producing shells of the required exactness, there was considerable delay and much disappointment experienced, both by the government and the contractors.

A new foundery was therefore built by government at Woolwich, and furnished with a set of apparatus capable of delivering two hundred tons of shot and shells daily, if such should ever be required. It is provided with fifty horse-power to work the machinery, eight large cupolas, and every facility for carrying on the shot and shell manufacture economically. The fuel and iron pass in at one side of the establishment; the moulds are conveyed by railway from the moulding area to the vicinity of the cupolas for the reception of the liquid metal, then, without having been removed from the carriage, they are conveyed onwards to the breaking up and cleaning department; the shells are put into the cleaning machine, and the moulding boxes with the core spindles undergo a rigid examination before being returned to the moulding area. The sand also has to be broken up, remixed, and sifted by machinery before it is returned to the moulders. The shells roll on to the bushing machines, after which, by their own gravity, they will roll along a suitable rail across the arsenal, out into the river by means of a long tube, and into the hold of a vessel for transportation.

In one day of twenty-four hours, during the late war, upwards of 10,400 shells passed through the machinery, a feat which probably could not have been accomplished in any other workshop in the world.

Towards the close of 1854, an urgent demand was made from the Crimea for wrought iron shells, an article of peculiar shape, not unlike an immense champagne bottle, which it was found impossible to get by contract in sufficient time and quantity to meet the demand. In this emergency, a factory capable of producing one hundred of these shells daily was erected; it covers 30,000 square feet, contains four steam engines, seven steam hammers, and upwards of forty machines of various descriptions, many of them original and specially adapted to this manufacture.

These shells are made out of a single plate or slab of iron into an article resembling a bottle in form, with six or seven heatings; a remarkable example of what well organized arrangements will accomplish. The shells, having to be of one uniform weight, are turned in a lathe, both inside and externally. The lathe-spindle, however, is a hollow trunk, which holds a shell at both ends, and each shell is acted upon by a dozen or more cutting tools simultaneously on both sides, and in opposite directions; thus the whole apparatus is thrown into a condition of equilibrium, and relieved of the inordinate amount of friction which would otherwise exist, and the time required is reduced in proportion.

IMPROVED METHOD OF MAKING CARTRIDGES.

The following is a description of a new method of making cartridges, recently introduced into the Royal Arsenal, Woolwich, England: —

Hitherto small arm cartridges have been made up with several pieces of paper that were rolled into the proper form, to hold the bullet and powder, an arrangement which has been found liable to some important objections.

A few years ago a method of making seamless sugar bags direct from the pulp, and without the intermediate stage of sheet paper having been invented, an inquiry was made in regard to its applicability for cartridges, and it having appeared, after careful examination, to offer several important advantages, more especially with respect to strength with a given quantity of paper, economy, and still more in regard to accuracy of dimensions, that system has, accordingly been introduced.

The special apparatus required for the small-arm seamless cartridge bag consists of a number of small perforated moulds, of the same form as the cartridge bag, which are clustered together on the end of a flexible pipe, in which a vacuum is kept up by means of an air pump. Each finger in this group of moulds is covered with a worsted slip cover, or mitten, and the whole cluster is then dipped into a cistern containing the liquid pulp, which in an instant is drawn upon them through the agency of the internal vacuum, combined with the external pressure of the atmosphere. The worsted mittens, with their paper covering, are then placed on driers of the exact dimensions, that are heated by steam, the whole operation of forming and drying occupying about a quarter of an hour.

IMPROVEMENT IN THE MANUFACTURE OF GUNPOWDER.

A patented improvement, by Henry Hodges, of New York, consists in mixing the ingredients or component parts of gunpowder (namely, charcoal, saltpetre and sulphur) in their usual proportions in the ordinary way, and in then putting them into a suitable pot or vessel, made of any description of metal or earthenware, into which vessel sufficient steam is admitted by any suitable apparatus to damp the composition, dissolve the saltpetre, and soften the sulphur. By these means the saltpetre is more intimately blended with the other ingredients than by ordinary processes of manufacture. During this process the composition should be kept well stirred up, to expose it as much as possible to the action of the steam, and this may be continued until the whole of the saltpetre is dissolved, when it is taken out, and when sufficiently dry is ground in the usual way.

IMPROVEMENTS IN POLISHING AND GRINDING PLATE GLASS.

The New York Tribune furnishes the following description of a new method of polishing and grinding plate glass, recently put in operation by a new company, in New York City.

The apparatus in question is the invention of Mr. Brougton, improved by Mr. P. Burgess. The grinder is a horizontal circular plate of cast-iron, ten feet in diameter, and two inches thick. The upper surface is planed, and has ribs beneath to give it strength. This large plate is keyed on the end of a vertical shaft, which is made to revolve at a velocity of forty-five revolutions a minute. Two horse power is all that is required. The plate of glass to be ground is placed upon the circular table just described; halfway between the centre and the circumference an adjustable frame of the proper weight is placed upon it so as to confine the edges and prevent the

plate from slipping away. This frame carries in its centre a round rod, standing vertically, which is kept in its place by two bars fastened to the frame of the machine. This arrangement prevents the frame from moving away, but does not prevent it from revolving. There is room on a circular table for four glass plates, disposed in a similar manner, at a distance from the centre. A trough full of sand, with an aperture in the bottom proportional to the quantity of sand required, is suspended above. The machine is put in operation by making the ten feet table revolve. The frames above being held in their place, the glass they carry is rubbed by the table, and the velocity being greater at the circumference of the table than near the centre, these frames themselves begin to revolve in a contrary direction. This motion, which is a result of the first, has the advantage of regulating the friction by successively bringing every point of the glass near the centre, where the friction is least, and near the circumference where it is greatest.

The polishing machine is nearly similar to the grinding machines. The only difference is that its upper surface is formed of wooden rings covered with felt, which are screwed upon the cast-iron table, and that these circular rings are eccentric to the table, and leave between them parallel circular ridges of nearly the same breadth as the wooden rings. The glass plates are placed upon this machine as upon the other, in exactly the same manner, but instead of sand falling on it from a box, oxide of iron or rouge, thoroughly mixed with water, is used, and is applied to the felt with a brush.

The polishing and grinding of plate glass has, heretofore, been effected by manual labor. By the above described apparatus, a result formerly requiring ten hours of labor, is said to be accomplished in one.

JOPLING'S IMPROVED WATER METRE.

At a recent meeting of the Institution of Civil Engineers, Mr. T. T. Jopling described a metre of his own invention constructed on the piston principle, which appeared to meet the objections hitherto made to that class of metre. It consisted of two measuring cylinders, set parallel to each other, with working pistons, — the rods of which projected out of the cylinders in opposite directions, carrying at their extremities slide valve frames, for supporting and operating on the slide valves that governed the ports of the cylinders. These measuring cylinders were contained in a cast-iron case or tank, into which the water to be measured entered under a certain pressure. The water thence passed into the cylinders, from which, after having acted upon one or other of the pistons, it made its escape. Through the agency of suitable counting apparatus connected with one of the piston rods, the reciprocating movements of the piston were counted, and thus the quantity of water passed through the metre, in a given time, was indicated. The measuring chambers were made somewhat like ordinary steam engine cylinders, as respected the inlet and outlet ports; but in one of the cylinders the direction of the inlet ports was inverted, in order that the right hand port might pass the water to the left hand end of the cylinder, and the left hand port to the right hand end. By this means the two pistons were enabled to follow

each other in the same direction, and to maintain a continuous stream of water, without the use of cranks. The slide valves were pressed up against the ports of the cylinder, by means of springs, in order to retain them in contact with the faces when the metre was at rest. They were free to remain stationary during the greater portion of the progress of the pistons ; but just as the piston of one cylinder was completing its stroke, one of a pair of tappets on the valve frame, carried by the piston rod of that cylinder, would strike against the valve which that valve frame carried, and altered its position over the ports of the other cylinder, whereby the direction of the flow of water into that measuring cylinder was reversed. For transmitting the reciprocating motion of the piston to the index, one of the valve frames was furnished at the back with two ribs, or feathers set parallel to each other, but one in advance of the other. These feathers acted as teeth, and in sliding backwards and forwards with the piston rod, they entered alternately the teeth of an escape-wheel, and so drove it round tooth by tooth. The arbor of this wheel led through the water case to the counting apparatus ; and thus motion was communicated directly to it, without the aid of pawls and ratchet-wheels.

By this arrangement the metre became a very simple and inexpensive machine, not liable to derangement ; or if injured, it was easily repaired, as the only moving parts were the two valves and two pistons. There was an entire absence of concussion ; the pressure of the head was preserved, and being similar within and without the cylinder, there was no friction upon the pistons ; and the water-tight external case or chamber served as a deposit for sand or other extraneous matter.

NEW SYSTEM OF NATURE PRINTING.

The following communication on the above subject has been recently presented to the London Society of Arts by Mr. C. Dresser.

The art of nature printing has been defined as " a method of producing impressions of plants and other natural objects in a manner so truthful that only a close inspection reveals the fact of their being copies ; " but this is rather the result of its greatest achievement — to us it merely implies printing from nature, and in this light it will now be regarded.

As this printing from nature, or " nature printing," is only in one sense new, its history may prove interesting and useful, as this, and this alone, can enable us to understand to what extent it is new, and the nature of any supposed improvements or alterations in the art which may be offered. As far back as about 250 years a simple mode of producing impressions of plants upon paper was employed by naturalists. The plant, after being dried, was held over the smoke of a candle or oil-lamp, when it became blackened by a deposit of soot, after which it was placed between two sheets of paper and rubbed with a smoothing-bone, which caused the soot to leave the prominences of the leaf and adhere to the paper. In this way an impression of the plant was produced. This method of procurring impressions was employed as early as the year A.D. 1650.

In 1707 Linnæus alludes to impressions taken by Hessel, from nature, who, at a later period, carried this art out to a considerable extent. The leaf or vegetable subject was prepared by being dabbed with printer's ink or lamp-black, after which it was placed between two sheets of paper, and subjected to flat pressure. Coloring the impressions by hand was introduced about this time, but not successfully.

Hitherto all the modes of producing impressions of plants have been similar, all involving a preparation of the botanical subject with a black pigment, and the application of pressure to procure the transfer. No attempt was made to multiply the impressions produced, a new vegetable subject being used for every impression or nearly so.

In 1833 nature printing again appeared, but it amounted to a new discovery.

The process was the discovery of Peter Kyhl, a Danish goldsmith. The vegetable subject, after being thoroughly dried, was placed between a plate of polished steel and a thoroughly heated lead-plate, which were united and passed between steel rollers, by which operation the plant became pressed into the lead, thus producing in this soft metal a beautiful concave image of itself.

The next step was the proposal of Professor Leydolt, in 1849, viz., that of printing from agates in such a manner as to represent themselves in a truthful manner. The agate is exposed to the action of fluoric acid, the result of which is, certain of the concentric scales are decomposed, while others remain unaltered; after this the surface is well washed with dilute hydrochloric acid and dried, then carefully blackened with printer's ink. A piece of paper being placed upon the prepared stone and rubbed with a burnisher, an impression was produced, the black parts being represented white, and the white black. This is now overcome by the surfaces being reversed: that is, the concave surface made convex, and the convex concave, which is effected by casting.

Dr. Ferguson Branson, in 1851, suggested the application of the electrotype, which has since proved itself to be an essential feature in this art. In 1852, he again made experiments. The mode he adopted was that of taking impressions upon Britannia metal, with a view of transfering them to stone, and after printing in neutral tint, to color such impressions by hand. This, however, failed to produce any practical results.

The next step was taken in the imperial printing office of Vienna, in 1851, or early in 1852. The first experiment made there appears to have been casting with gutta-percha, as Dr. Branson had done, but as this material did not altogether answer, Andrew Worring proposed the substitution of soft lead, which he used as Kyhl had formly done; the specimens operated upon being lace. Professor Haidinger proposed the application of the process to plants, which suggestion Worring gladly availed himself of. After he had prepared the moulds, in the manner just described, he, by the agency of the electrotype, produced plates prepared for the printing-press. This process was at once applied to practical purposes, and several botanical works have already been illustrated by his agency. This process was first patented in

Austria in the year 1853, and since in England by Messrs. Bradbury and Evans.

There is one other form of nature printing, viz., that of Felix Abate, of Naples, for producing representations of the grain of wood as exhibited by sections. This process depends in a great measure upon heat.

We have now noticed four distinct forms of nature printing; the first being that in which the object was prepared by being blackened; the second, the impressing of vegetable objects into soft metals; the third, the preparation of minerals, so as to render them capable of producing images of themselves; and the fourth, the preparation of wood, so as to render it capable of yielding impressions which are its true image; these are distinct varieties.

Mr. Henry Bradbury states that we are indebted to Kniphof for the application of the process in its rude state; to Khyl for having first made use of steel rollers; to Branson for the first suggestion of the electrotype; to Leydolt for the remarkable results he obtained in the representation of flat objects of mineralogy; to Haidinger for having promptly suggested the impression of a plant into a plate of metal at the very time the *modus operandi* had been provided; to Abate for its application to the representation of the different sorts of ornamental woods on paper, &c.; and to Worring for his practical services in carrying out the plans of Leydolt and Haidinger. In this statement he supposes each man to have been acquainted with the works of those who had gone before him; but it is improbable that this was the case.

Mr. Bradbury states that if anything but a *thoroughly dried* vegetable specimen be placed between the plates of soft lead and steel, it will be spread in all directions and distorted to an unlimited extent, without leaving any impression in the soft metal, save a most undesirable one; therefore, the use of *thoroughly dried* specimens, and those only, is a necessity of the process. To this drying there is this objection — that the texture is frequently destroyed. Another objection is, that the necessary pressure frequently shatters the specimen.

We shall now proceed to notice a new process of "nature printing," in that of using natural objects, leaves, or flowers as a printing surface, and printing with them on a lithographic stone, or metallic plate or cylinder, and after subjecting them to the usual processes for rendering them fit for printing, taking impressions in the usual ways.

The precise mode of procedure is as follows: —

1*st. The lithographic process.* "We take a leaf, for example, and carefully dab it with lithographic ink. To enable us to coat the leaf evenly with ink, a small quantity of the latter is placed on a piece of damp writing paper, which rests upon several sheets of damp paper or cloth, under which is situated a warm metallic disc. The ink is spread thinly over the sheet of writing paper, and the leaf to be reproduced is placed upon it. The leaf is dabbed with the ink dabber, the latter being renewed with ink from the surrounding paper. The leaf is placed with the prepared side downwards, on a lithographic stone which has been previously warmed. A sheet of

paper is then laid over the leaf, and rubbed with a soft pad, which presses the leaf in contact with the stone, and makes the impression. The stone is now subjected to the usual lithographic processes, as if it were a drawing.

2d. *The metallic plate process, printing from a raised metal surface like a wood-cut or type.* "We take a leaf and prepare it in the manner above described, substituting, however, for the lithographic ink, a composition made by melting together about equal quantities of, 'etching ground,' 'common tallow,' or 'balsam of Judea,' and 'sweet oil,' and for the sheet of writing paper a porcelain or metallic plate, which plate is placed over warm water. The leaf is now laid upon the metallic plate. A piece of paper is placed over the leaf and rubbed as before. Upon removing the paper and leaf, a true impression of the latter is made upon the plate, and all that remains to be done is to remove the metallic ground surrounding the impression and intervening between its parts, which is accomplished by the well-known etching processes as that of employing dilute acids, or by the agency of galvanism, the latter being preferable. The plate is now engraved, and a true convex image of the leaf is produced. The plate may then be printed from as if it were type or a wood engraving."

3d. *The ordinary copper plate or cylinder process, the engraving being concave.* "We take a metallic plate, and thinly coat it with 'etching ground." The leaf is prepared by being dabbed with oil paint, the same as that used by artists, which has been spread over a sheet of paper. The leaf is placed upon the etching ground, and a piece of paper laid over it, which is rubbed as before. We now remove the paper, and in about one minute the leaf also. Now, where the oil paint has touched the 'etching ground,' the latter is dissolved, which is at once carefully wiped off with a soft rag, the copper now appearing through where the ground is removed. The plate is now washed with soap and water to remove all remaining grease, and then subjected to the usual etching processes. In this case the image of the leaf is concave, and is printed off by the usual copper-plate printing process. When rollers or cylinders are employed instead of plates, the process is similar."

The ordinary mode of etching by acids does not answer, as before the ground is eaten away sufficiently to enable the convex figure of the leaf to be printed from, the finer parts are destroyed by the lateral action of the acid. By the electrical etching, however, the results obtained are highly satisfactory. The results from endeavoring to eat off, by the agency of oils, "etching-ground," from a plate which had been covered with this substance, the image being concave, are at present uncertain. This method of producing similar results seems, however, to bid fair for success, — viz., that of taking the impression of the vegetable object in grease upon a steel plate, and etching it, not very deeply, by electricity, then pressing this etching into soft copper (as is done in the preparation of cylinders for calico printers), after which the etching on the copper plate or cylinder is deepened by the ordinary re-etching process.

A word must be said upon the cost of the process, as this necessarily

influences the commercial value of all discoveries. Respecting the lithographic method, the whole expense may be said to be that of printing off the impressions, as the cost of materials for one transfer of a leaf on to the stone is less than one half-penny, and the time necessary for producing the original figure on the stone is a few minutes. Both the other modes are about as speedy, with the exception of the etching, which, occupying rather more time, hence involves a little more labor and expense, which is, however, more than compensated for in the process of printing from raised copper figures, as the expense of printing off impressions is in this case extremely small, owing to the durability of the blocks employed, the most expensive form of the process must be below that of the process at present employed.

ON AN IMPROVED METHOD OF PREPARING PRINTING SURFACES.

This invention, by M. M. Chevalier and O. Sulivàn, of Paris, has for its object to obtain printing surfaces as a substitute for lithography and other similar methods of printing, the use of which, besides being much cheaper than lithographic printing, offers this advantage, that a design consisting of a number of different colors can be printed at one and the same time; while in ordinary printing each color has to be worked off separately, and entails a great amount of labor.

In carrying out the invention, the patentees take any suitable permeable substance or fabric, such as linen, calico, cloth, canvas, or other woven or suitable material, or, it may be, a reticulated metal surface, or metallic plate or sheet, perforated with minute holes to impart the required degree of permeability, and on this surface they draw or write the desired figures or characters in an ink composed of lamp-black, Indian ink, gum, sugar, and salt.

A coating of this ink being applied to the permeable surface in the form of the design or character or characters required, they next coat the permeable substance, on the side drawn upon, with a thin coating or film of gutta-percha or of gelatinous material, covering the drawing as well as the other part of the permeable material. When the coating of gutta-percha or other gelatinous material is dry, the fabric, or other surface, so coated, is washed. The gutta-percha or gelatinous materal, at that part where it comes in direct contact with the permeable material, adheres firmly thereto; but at those parts covered by the ink, it has no such adhesion, and simply holds to the ink design. The ink, being readily soluble in water, is removed in the washing, and carries away the gutta-percha covering it; thus the design drawn upon the permeable material is now the only pervious part remaining in the surface.

The back part of the pervious substance or fabric is now to be coated with the ink or color or colors required to be printed; and the ink or color having been applied, the impression is taken from the face of the fabric or substance by pressure in a suitable press; the paper or surface to be printed being placed in contact with the face of the fabric or printing surface, the ink or

color passes through the pervious part, and is thus applied and printed on the paper or other surface required.

Instead of applying the ink or color to the back of the pervious material, the design in that material may be placed on a pad containing a reservoir of ink or color, by which the ink or color is supplied by pressing it on such pad; from which it passes through the pervious parts of the material constituting the design, to the paper or substance placed on the face of the printing surface to receive the impression.

IMPROVEMENT IN PRINTING PRESSES.

An apparatus has recently been patented by M. Y. Beach, Esq., proprietor of the N. Y. Sun, for turning the sheet in printing newspapers, and printing it upon the second side before it leaves the press. The invention, as now used, is attached to one of Hoe's Cylinder Presses.

In its operation there is no checking or reversing the ordinary movements of the press. A double or twin set of fingers, which shut against each other, are so arranged as to grasp the back or tail end of the sheet before it leaves the printing cylinder, and after the first impression is taken. The sheet, thus held fast while the cylinder continues to revolve, is drawn in again for the second impression, and thus the feeding the sheet by hand the second time, or fifty per cent. of the labor now required is saved, and, practically, the sheet is printed on both sides at once — two forms instead of one being placed upon the press.

RENDERING FABRICS FIRE PROOF.

An English patented discovery, by Mr. Maugham, has for its object an improvement in the preparation or manufacture of starch, and consists in preparing starch which shall have the property of rendering the fabrics to which it may be applied incapable of transmitting flame or fire. For this purpose, the starch having been manufactured, is saturated or mixed with phosphate of ammonia, and a small quantity of muriate of ammonia. The starch is afterwards dried or prepared, to render it suitable for the market.

After the water is decanted off at the end of the process usually practised for making starch, and before the starch is dried, the phosphate of ammonia is incorporated therewith, in the proportion of 480 grains to one ounce of the moist starch. The starch is then to be dried in the usual manner, when it will be fit for the market, and is to be mixed with water and applied to the fabric in the usual way. Or, after the starch has been made by any of the usual methods, and has become dry, phosphate of ammonia is added, in the proportion of 600 grains of the salt to one ounce of starch, and the ingredients are then ground together. The starch is now ready for use, and may be mixed with the usual quantity of water, and applied to linen or other fabrics in the ordinary way. It is, however, to be observed that the fabrics should not be thoroughly dried and then sprinkled with water, after the manner generally adopted by laundresses, before ironing, but the fabrics should be partially dried, and then rolled tight in a dry cloth, and allowed to remain some time before ironing; and to prevent the iron from sticking, a little

clean tallow or white wax should be previously added to the starch when it is being mixed with the water. When starch is to be used for coarse fabrics for the purpose of rendering them fire proof, muriate of ammonia may be employed with the phosphate of ammonia, and in that case the phosphate of ammonia is to be diminished in proportion to the quantity of muriate of ammonia added.

RENDERING STUFFS WATER-PROOF.

The following is a description of a method patented by M. Menoti, of France, for rendering stuffs water-proof, and yet allowing them to remain permeable to air. We translate the French measures, assuming the litre as a quart, and the kilogramme as two and a quarter pounds avoirdupois.

Take two vessels of a capacity of five gallons each; place in one twenty-two pounds of alum; in the other, nine pounds oleic acid, and one and a half gallons alcohol. Stir this mixture well, and pour it into the first vessel, taking care to stir well with a wooden ladle during the mixture, and for ten minutes afterwards. Let the mixture stand for twenty-four hours, then decant the oleic acid and alcohol which are floating on top. Throw the precipitate upon a felt filter, and press until all the liquid is run out. Take the precipitate from the filter and dry at eighty-six degrees; when dried, powder it by rolling it upon a table with a wooden roller. This compound the author calls *hydrofugine*. To use this, dissolve it in 150 times its weight of warm water for woollen stuffs, while for linen, cotton, or silk, 100 times the weight will be enough. Filter the solution through linen, and plunge the stuffs to be water-proofed into it; soak them well, then take them out and wring them; soak them a second time, then take them out and dry them either in the air or before a fire. The stuffs, when well dried, are impermeable to water, but not to air. The quantity of hydrofugine necessary cannot be accurately determined, but generally one ounce is enough for two yards of cloth or four of muslin.

M. Thieux, of Marseilles, proposes a simpler process. In two vessels, each of a content of twelve gallons of river water, are dissolved, in the one three and a half pounds of alum, in the other the same weight of sugar of lead. When the solutions are complete, pour the liquids together, by which will be formed an insoluble sulphate of lead, and soluble acetates of alumina and potassa, mixed with a slight excess of alum. As soon as the liquid has become clear, it is drawn off and the stuffs plunged into it; they must be strongly compressed while under the liquid, to expel the air from their pores, and then suffered to soak for at least four hours, so as to insure the perfect penetration of the liquid everywhere. When withdrawn they are lightly shaken, then dried, brushed, and pressed with a hot iron. It appears that various specimens of cloth experimented on by a committee, absorbed from eleven to seventeen per cent. of their weight of saline matters, and retained their original appearance, and their pliability at all temperatures. But after immersion in fresh water for twenty-four hours, they lost all their additional weight. As to the efficacy in this process, there appears to be a very serious difference of opinion; the conclusions of a committee ap-

pointed to examine it, as reported by M. Jacquelan, are that it is not new, nor as good as was announced; but it had been tried and approved for five years by the Lyons and Mediterranean Railroad Company; that the Committee could not tell whether it was durable or not; its cost was about twenty cents for water-proofing a coat or pair of pantaloons. On the other hand, M. Balard, known to all, as one of the most distinguished and careful chemists of France, reports that the thinnest woollen cloths impregnated with it are totally impermeable to water after weeks of contact with it, that the water evaporates from them, and does not pass through; that clothes which had been soaked for forty-eight hours in fresh water, were as impermeable afterwards as before; but that the transpiration from the skin appears to destroy the impermeability, so that it is probably applicable only to exterior clothing; finally, that there is every probability that it is lasting, as appears from the certificates. M. Balard himself testifies that an overcoat worn by him for five months, which had been beaten and rubbed and subjected to all the ordinary usage of overcoats, remained perfectly impermeable. Clothes prepared in this way are said to be softer to the touch, warmer, absorbing less moisture, drying more quickly, and therefore more durable.

It would appear, therefore, that this process, which is cheap and easily applicable, even after articles are made up, is well worth experimenting upon. — *Bull. Soc. Encour., Sept. and Dec.*, 1855.

Waterproofing Paper, Cloth and Leather. — P. Pierre Hoffman, of Strasbourg, has taken out a patent in England for a new varnish, which, when applied to the articles named in the above caption, render them, it is stated, air and water-proof, while at the same time they keep dry under all variations of temperature in the open air, are elastic and do not become sticky — the latter being a fault common to a number of varnishes. The articles are coated with a mixture either of siccative linseed oil and sulphur, called balm of sulphur, or of a mixture of sulphur with a quantity of siccative oil, gum copal, gum opal, yellow amber, resin, india rubber, and gutta percha and with the essences of turpentine or naphtha, etc., these two latter keeping in solution the above named substances, which may be mixed separately or at the same time with the balm of sulphur.

The chief features of the invention consist in the use of the balm of sulphur for rendering fabrics air and water-proof, and in preparing the balm in the following manner: — When the siccative or common drying oil has boiled for about two hours, in order to thicken it and separate its mucilaginous parts it is left a few days to settle, previous to decantation; then ten parts, by weight, are taken and submitted to slow boiling, during which small quantities of flowers of sulphur are added, and agitation is kept up the whole time. When from one to two parts of flowers of sulphur have been thus thrown in small quantities into the oily mixture, a transformation soon takes place, and the balm of sulphur now assumes a homogeneous mass of a brownish color, cohesive and elastic, somewhat like india rubber. The constituents of this composition or coating are then the following (by weight): Ten parts of siccative thickened linseed oil, and from one to two parts of sulphur in powder. The balm of sulphur, thus prepared, is used as the

coating, and liquified either by the action of heat, or by means of solvents, such as spirits of turpentine, naphtha, etc. When it is desired to obtain a harder coating, gallipot gum, yellow amber and resin, etc., may be added.

The fabric to be coated is dipped into the material when hot, and in the liquid state, from which it is withdrawn and made to pass between six scrapers adjusted transversely above the vessel, so that any excess of the material is removed, and drops into the vessel again.

To Render Paper Impervious to Water. — Take twenty-four ounces of alum, and four ounces of white soap, and dissolve them in two pounds of water; in another vessel dissolve two ounces of gum arabic, and six ounces of glue in the same quantity of water as the former. Add the two solutions together, which is now to be kept warm. The paper intended to be made water-proof is dipped into it, passed between rollers, and dried; or without the use of rollers, the paper may be suspended until it is perfectly dripped and then dried. The alum, soap, glue and gum form a kind of artificial leather, which protects the surface of the paper from the action of water, and also renders it somewhat fire-proof.

PREVENTION OF DECAY IN STONE-WORK.

The following are recent inventions, introduced or patented in England, and on the continent, for the prevention of the decay of stone-work under the various climatic influences to which it is exposed. By the employment of a solution made of one part by weight of sublimed sulphur in eight parts of linseed oil, heated in a sand-bath to a temperature of 278 degrees Fahrenheit, the vegetable mucus of the oil is precipitated, the watery particles evaporated, and their place supplied by the sulphur, which is readily taken up by the oil at the above temperature. The solution should be applied by a common painter's brush, until the stone will absorb no more. Stone thus indurated becomes almost equal to granite in hardness, and, as far as a test of four years can prove, not only shows no symptoms of decay, but actually increases in hardness.

Another invention, patented by Mr. H. C. Page, of London, has for its object the preservation of the beauty, color and value of marble and stone, as well as their sharpness when sculptured. The following is the process adopted: — The surface of the marble or stone is wetted with a solution composed of two parts of lime and one part of pearlash. The stone is then exposed to a gradual heat until dried, and, when sufficiently hot, white beeswax is passed quickly over the surface. This should be done two or three times should the marble or stone be very porous; the surface should then be cleaned while the stone is warm, and afterwards cooled by pouring cold water upon it. Variegated patterns or devices in colors may also be produced by applying them to the surface according to the taste of the artist, and the stone then heated, beeswax rubbed over it, and cooled by water as before. Common stone work may be indurated by dissolving one pound of calcined beeswax in one gallon of coal-tar naphtha, and applying the mix-

ture with an ordinary painter's brush over the surface of the stone, which is then cleaned with pumice-stone or other fine grit, and clean water.

Ransome's process for preserving stone, which has received high commendation in England, consists in coating the stone or other material first with a solution of a soluble silicate, and afterward applying a solution of chloride of calcium, with a view of forming an insoluble silicate of lime in the body of the stone. In place of a soluble silicate and chloride of calcium, other preparations may be used; the invention consisting in the application in succession of two solutions, which, by mutual decomposition, produce an in insoluble substance, which is deposited in the structure and on to the surface of the stone or other material. It is claimed that this application not only prevents new stone from decaying, but effectually prevents the further decay of that which is already rapidly approaching disintegration. The efficacy of this mineral is not confined to stone alone, but may be applied to brick, lime, stucco, etc., with equally effective results.

NEW WATER-PROOF GLUE.

The following is the composition of a new water-proof glue, which is said to be superior to the well-known "Jeffries' Marine Glue."

Dissolve one-fourth of a pound of common glue in water the usual way; then dip into it some clean white paper, sufficient to take it all up. When the paper is nearly dry, cut it into strips and put them into a common glue pot; add one pound of alcohol, and boil gently for one hour. Then take out the paper — the only use of which is to give the glue more surface for the action of the alcohol — and add one fourth of a pound of powdered gum shell-lac; continue the heat, gently stir the mixture until the shell-lac is dissolved, and then evaporate it to the proper consistence for use. For cement add more shell-lac and prepare it thicker.

Elastic Glue — M. Lallemant, of Paris, finds that by mixing gelatine with an equal weight of glycerine, it is rendered permanently elastic, and is preserved from putrefaction. This material may be used for dentist's purposes, for printers' inking rollers, &c.

NEW GOLD VARNISH.

A beautiful and permanent gold varnish, which does not lose its color by exposure to light and air, may be thus prepared: — two ounces of best French garancine to be digested in a glass vessel with six ounces of alcohol of specific gravity of 0,833 for twelve hours, pressed and filtered; a solution of clear orange-colored shell-lac in similar alcohol is also prepared, filtered, and evaporated, until the lac has the consistence of a clear syrup. It is then colored with the tincture of garancine. Objects coated with this have a color which only differs from that of gold by a slight brownish tinge. The color may be more closely assimilated by a little tincture of saffron.

Moulds of Stearic Acid and Shell-lac for Galvanoplastic Copies. The best material for moulds is prepared from equal parts of stearic acid and shell-lac. The stearic acid is melted first, and the shell-lac is then added in small

fragments; the mass is heated until it becomes ignited. It is allowed to burn until the shell-lac which separates from the stearic acid by the great heat, again combines with it. The ignition is continued until a drop let fall upon a cold metal plate receives the black lead readily after its solidification. The mass is poured into a paper box, and its surface rubbed with black lead. — *Polyt. Notizblatt.*

EXTRACTING COLORING MATTER.

L. P. Kerdyk, of England, has invented an apparatus for extracting coloring matters, which consists of an interior case or chamber covered with wire cloth and perforated plates, &c., and revolving at a high velocity, inclosed in an exterior chamber or case. The pulverized wood or root is placed in the internal chamber, and rotary motion being imparted thereto, water is introduced, and driven or filtered out by centrifugal force through the sides of the case. The insoluble matter remaining behind is removed when requisite. The liquid thus separated may be passed into the material, and out through the machine again, and so on, as often as necessary, until the color is sufficiently extracted from the roots.

AGEING LIQUORS.

Wines and liquors are in general esteemed in proportion to their age. Various expedients have been resorted to for giving to liquors "age" more rapidly. In ancient times the wine was placed in skins, and hung up in the smoke of a fire, where it would receive a gentle heat. A constant movement of the particles of the liquid was thus occasioned, and the qualities due to age were obtained in less time than when not exposed to warmth. The mode frequently adopted of late years to obtain "age" in the least period of time is to put the liquors on board of ships, and send them on voyages through the tropical climates. The gentle undulations of the sea combined with the heat of the atmosphere in the tropics give both motion and warmth to the liquids by which their qualities are sensibly improved. In other words, "age" is thus imparted to them, and liquors are increased in price in proportion to the number of times they have crossed the equator.

An American improvement recently patented by Messrs. A. &. A. Walcott of Bloomfield, N. Y., consists in subjecting the liquors to what may be termed an artificial sea voyage. They place the liquor upon shelves. which are gently swung to and fro, the apartment being suitably heated and kept dark. Heat and undulation are thus conveniently communicated, and the desired "age" is obtained in much less time than by any other known method. This improved process continued for one year gives, it is stated, a value to the liquors which requires four years' time to attain by the ordinary means. — *Scientific American.*

CONTRIVANCE TO PREVENT LIQUORS BOILING OVER.

This contrivance, the invention of Mr. J. Lieblong of Waterbury, Ct., consists in placing a conical shaped cap within the vessel, said cap having

an opening at its apex, over which a deflecting plate is placed. The whole is so arranged that the boiling liquid will pass up through the opening in the apex of the cap and striking against the deflecting plate, will run down again into the vessel. The liquid is thus effectually prevented from passing over the sides of the vessel.

DURABILITY OF GUTTA PERCHA.

Some interesting statements respecting the durability of gutta percha have recently been made public. From an inspection of the underground wires of the British Telegraph Company, conducted by Mr. E. Highton, it appeared that they had decayed wherever they had passed near the roots of an oak. On examination, the root and gutta percha were found to have both been attacked by a yellowish white fungus, which had destroyed the gutta percha wherever brought into contact with it. This was not found to be the case under any other tree, but at Winslow such wire as has had been inclosed in iron piping was found to be decayed, while that in the usual wooden troughs was sound. Here the destruction was evidently not the work of fungi: but Mr. Highton's experiments have led him to the conclusion that the spawn of the common agaric, and presumably of its congeners also possesses the property of decomposing gutta percha; and it is said that Dr. O'Shaughnessy has found the telegraphic wires sent out to India unserviceable, on account of the disintegration of their gutta percha envelops. Considering how extensively the gum has come to be used, these facts must be thought to deserve attention.

IMPROVEMENTS IN TANNING.

At a recent meeting of the N. Y. Mechanics' Institute, Professor Mapes described a new centrifugal apparatus by which he bad been enabled to force the tannic acid through every part of the raw hide by means of centrifugal force generated in a rapidly revolving perforated cylinder resembling the sugar machines.

By the prevailing modes it requires about seventy days to tan completely the average of raw hides, while by the improved process Professor Mapes said that he had succeeded in tanning a calf skin thoroughly in less than fifteen minutes. The process he used was to place the hide around the inside of the cylinder, and holding it there by means of the centrifugal force resulting from a very high velocity, and then passing a stream of tan liquor into the centre, which was then carried by the centrifugal force against the hide, and passed through under the intense pressure, after which it escaped through the perforated cylinder into a surrounding vat, and was returned to perform the same journey over again until the tannic acid was exhausted. Mr. Schultz stated that he had experimented with the hydrostatic column in the tanning of calf skins, and found that the process produced the most positive results, the raw hide being thoroughly tanned in about fifteen minutes — the height of column being about twenty-five feet.

ARTIFICIAL HARD GRAIN OF LEATHER.

To give any kind of leather the appearance of genuine *hard grain*, J. A. Richards, of London, takes a skin of real hard grained leather, electrotypes it, and then bends the plate thus produced round a roller or drum, and mounts it on a shaft. He then passes the leather to receive the hard grain appearance under this roller, which is subjected to great pressure.

ON THE MANUFACTURE OF KELP.

From recently-published satistics we derive the following information relative to the production of kelp and its resulting products in Ireland and Scotland:

The quantity of kelp imported into Glasgow is generally about six thousand tons annually, although it has reached near twelve thousand in one year. Of this amount about seven thousand tons are produced in Ireland, and the rest in Scotland. The average price of kelp at the several places of collection is twenty dollars per ton. The average cost to the manufacturer is twenty-five dollars. The aggregate amount expended annually upon this product of the ocean is thus shown to be about $225,000.

From these figures some idea may be formed of the value of this manufacture to the inhabitants of the sea coast, and they are well worthy the attention of the inhabitants of the Maine and Nova Scotia seaboard.

The average amount of Iodine procurable from a ton of kelp is about nine pounds. The salts of Potash, however, constitute a very important element in calculating the yield of kelp. The following table gives some idea of the yield of 9,000 tons of kelp:

9 lbs. Iodine per ton,..	81,000	pounds
500 lbs Chloride Potassium per ton,..........................	4,500,000	"
150 lbs. Sulph. Potash, per ton,................................	1,350,000	"
800 lbs. mixed Carb. Mur. and Sulph. Soda, called Kelp Salt,	2,700,000	"

The insoluble residuum which remains after the exhaustion of the soluble contents of the kelp, and which amounts to about one half the original weight, when mixed with sand is the flux used by the glass bottle makers in Scotland, the price paid being generally one dollar per ton.

ARTIFICIAL WHALEBONE.

In 1855, Joseph Kleeman, Meissen, Germany, obtained a patent for a mode of preparing a substitute for whalebone. The process has recently been successfully introduced into New York City.

It consists in taking sticks of the common ratan and soaking them in a liquid extract for about four days, after which they are immersed in a solution of any of the iron salts, which gives the ratan a deep black dye. Subsequently the sticks are exposed in a close vessel, for the space of about one hour, to the action of steam of about three or four atmospheres' pressure, and then thoroughly dried in a furnace or drying-room at a temperature of

about 180 degrees, Fah., when they become ready for the impregnating process.

The sticks are then placed into an iron cylinder (capable of standing the pressure of at least ten atmospheres), connected by a pipe with an open vessel, containing a varnish made by dissolving 120 parts of shell-lac and 200 parts of burgundy pitch in ninety parts of absolute alcohol. The air having been exhausted from the cylinder, the cock connecting it with the vessel containing the varnish is opened, when the atmospheric pressure will force the varnish into the cylinder and into the pores of the ratan.

The impregnation of the ratan is rendered more perfect by the use of a pump for forcing the solution into the cylinder. The ratan has now changed its character, and become hardly distinguishable from the best quality of whalebone, except that it is somewhat more elastic and less liable to splinter and break. It has gained one hundred per cent. in weight by impregnation. After being removed from the cylinders, or impregnators, but little remains to be done in the way of drying, polishing, and fitting the ends, etc., to prepare it for use for umbrellas, parasols, canes, etc., and various other purposes.

The following is an extract from the specification of an English patent, recently granted for preparing cane, in order to render it a substitute for whalebone: The cane is first cut by being passed between two circular saws, the cane being moved past the saws by two grooved rollers, and it is supported by a grooved bed or guide, on to which it is pressed by a pressing roller. The canes having been properly cut on four sides, they are to be impregnated with a preparation of animal matter, which is obtained as follows: Bones are steeped in a solution of chloride of lime, the bones having afterwards been dried, are softened by digesting with steam; they are then combined with a solution of alum, and the filtered liquor obtained is employed for impregnating the canes, by placing them in a suitable closed vessel with such fluid, and subjecting the same to a pressure of about twelve atmospheres. After the impregnated canes have been dried in currents of air, they are soaked in a solution of alum, and again dried and finished for use.

IMITATION MARBLE.

A patent granted to the Penrhyn Marble Company, of Boston, for the manufacture of artificial marble, has reference in particular to a method of applying the colors by means of a peculiar bath, used in place of the ordinary size bath, long familiar in the manufacture of marble paper. The bath patented, consists in a film of Dammara resin floated upon water, which may be broken up into any desired figures, by means of a rod or spatula, previously dipped into the desired colors. The bath thus prepared is said to be more manageable than the ordinary one.

The article to be "marbleized," which is generally a surface of slate, is, after being prepared with the ground color, immersed in the bath, then withdrawn, dried or baked in an oven, and then coated with a proper varnish, and again heated.

Compared with the "marbleized iron," these objects are better imitations of the stone, because the iron has to be covered with a glass to give it the stone surface, and the thickness of this transparent coating shows itself in certain cases; and they are more durable, because the different expansibility by heat of the iron and glass, finally causes the latter to crack, and the iron then rapidly rusts. The new material is free from both these objections, but, on the other hand, the imitations of carved work cannot be done so cheaply as in the iron.

A method recently introduced by Mr. Felix Abate, of Naples, for making plaster of Paris as hard as marble, and rendering it susceptible of receiving a beautiful polish, is as follows: He places the plaster in a drum turning horizontally on its axis, and admits steam from a steam boiler; by this means the plaster is made to absorb in a short space of time the desired quantity of moisture, which can be regulated with the greatest precision. With plaster thus prepared, and which always preserves its pulverulent state, he fills suitable moulds, and submits the whole for a short time to the action of an hydraulic press. When taken out of the moulds, the articles are ready for use.

The plaster thus prepared is perfectly hard and compact, taking the polish of marble. The most delicate bas-reliefs and highly-finished medals may be produced from it with the same perfection as they have in the original.

THE SALT MANUFACTURE OF THE UNITED STATES.

The following comprehensive account of the manufacture and consumption of salt in this country was written in answer to a request for the statistical information it contains, for the use of a committee of the British Parliament. Its author is a prominent salt merchant of New York City.

Estimated Quantity of Salt Manufactured in the United States, per Annum.

	Bushels.
In the State of Massachusetts (mostly in vats built along the seashore),	46,000
In the State of New York (Onondaga County), about	6,000,000
In the State of Pennsylvania (Alleghany and Kiskiminetas river),	900,000
In the State of Virginia (Kanawha and Kings Works),	3,500,000
In the State of Kentucky (Goose Creek),	250,000
In the State of Ohio (Muskingum, Hocking River),	500,000
In the State of Ohio (Pomeroy and West Columbia),	1,000,000
In the State of Illinois,	50,000
In the State of Michigan,	10,000
In the State of Texas,	20,000
In the State of Florida,	100,000
Total,	12,376,000

There are salt lakes in the United States Territories, — one in the south-westerly part of Texas and one or more in Utah, where salt of good quality is found in great abundance.

Nearly all of the salt manufactured in the United States is made by boiling, excepting what is made in Massachusetts, Florida and the Solar Works at Onondaga.

The amount of salt manufactured at the Solar Works of Onondaga in 1856, was 709,391 bushels. The amount of salt manufactured in kettles in Onondaga in 1856, was 5,257,419 bushels.

When the works (at Onondaga) are generally running, they require 3,000,000 gallons of brine daily, and the supply is not less than 2,000,000 gallons per day for six months.

The wells in the Virginia Salt Springs are about nine hundred feet deep. The wells at Pomeroy and West Columbia are from one thousand to twelve hundred feet deep.

The estimated quantity of foreign salt consumed in the United States and Territories is about 13,500,000 bushels per annum.

The amount or salt consumed in the United States (for various uses) is about sixty pounds to each inhabitant.

The consumption in France is estimated at twenty-one and a half pounds; in Great Britain, at twenty-five pounds for each inhabitant.

The cost of manufacturing salt by boiling in Onondaga, as per estimate, during five consecutive years, averages about one dollar per barrel of 280 pounds.

The minimum price of salt at the Onondaga Works in 1849, 1850, and 1851 was from seventy to ninety cents per barrel; in 1852, one dollar per barrel; in 1853, $1,12; in 1854, $1,25; in 1855, $1,30, and in 1856, $1,40 per barrel.

The solar salt costs about the same price to manufacture as boiled salt.

The solar salt weighs about seventy pounds to the bushel (measure). The boiled salt weighs about fifty-six pounds to the bushel, varying, however, according to the position of the kettles, to a weight considerably above and also considerably below this standard.

The duty paid to the State of New York on salt manufactured at Onondaga is always reckoned on fifty-six pounds (this being the statute bushel), and covers the expense incurred by the State for pumping up the water and delivering it to the premises of the manufacturers.

A salt *block* at Onondaga, of the largest size, is made of brick, about twelve to fifteen feet wide, four to five feet high, and forming two parallel arches, extending the whole length of the block. Over, and within the top of these arches, are placed common cast iron kettles, holding about fifty to seventy gallons of brine, placed close together in two rows the whole length of the arches. A fire built in the mouth of the arches passes under each kettle into a chimney, built generally fifty to one hundred and fifty feet high, averaging from fifty to seventy kettles in each block. A single block with one row of kettles is about half this width.

The quantity of salt made in one of these double blocks in the year (say of eight months) averages 20,000 to 25,000 bushels of fifty-six pounds.

The cost of a bushel of salt produced at Kanawha is about seventeen and a half cents.

The price of freight on a sack of Liverpool salt, from New Orleans to Louisville, averages about thirty-five cents per sack.

A good portion of the coarse hard salt imported into the United States from the most southerly islands of the West India group, is kiln dried, cleansed, ground very fine, and put in small packages for culinary or dairy use. The amount of coarse and fine salt imported into the United States from foreign countries during the year ending June 30, 1856, was 15,405,864 bushels. The amount of domestic salt exported during the year ending June 30, 1856, was 698,458 bushels. The amount of foreign salt exported during the year ending June 30, 1856, was 126,427 bushels.

IMPROVEMENT IN THE MANUFACTURE OF SALT.

Where artificial heat is employed to produce salt, the brine is placed in large kettles, and the fire applied beneath. After the brine has become reduced to what is called "strong brine," and begins to crystallize, it is liable to cake up and collect on the bottom of the kettle. It is in part kept clear by attendants, who stir up the mixture, scrape it off, etc. But in nearly all cases there is some caking and a partial discoloration of the salt, which tends to diminish its selling value.

An improvement, patented by J. P. Hale, of Kanawha, Va., consists in the use of two kettles placed one inside the other, a space being left between. The weak brine is boiled in the lower kettle against which the fire is applied. After the liquid has boiled down into "strong brine" it is drawn off into a vat, where it remains long enough for its impurities to settle. It is then pumped into the upper kettle and crystallized, no stirring being required, as no caking or discoloration occurs. The upper kettle is heated by the hot brine between it and the lower vessel.

Mr. J. L. Humphrey, of Syracuse, N. Y., has invented an improvement in Salt Evaporators, which consists in an arrangement whereby the heated products of combustion from a furnace are drawn, by a blower, through flues passing through a closed evaporation vessel below the surface of brine, or other liquor, and by the same blower are forced back again, through the vessel, over the surface of the liquor, and into the chimney of the furnace. The heat from the furnace is thus used to effect evaporation both below and above the surface of the liquor, and the draft of the chimney is employed to carry off the evaporation. The improvement consists, further, in a scraper fitting to the flues below the surface of the liquor, and having a movement back and forth along the tubes, to remove the deposit which is caused to incrust itself upon them by crystallization, and which, if not removed, would prevent the heat being rapidly conducted to the liquor.

IMPROVEMENTS IN APPARATUS FOR SOLAR EVAPORATION.

An improved arrangement for evaporation by solar heat, recently patented by Mr. Gordon, a distinguished engineer of London, consists in employing reflecting apparatus, or concentrating or refracting lenses, or both combined, in such a manner that the heat of the sun's rays is for hours continuously rendered applicable for purposes of evaporating and even distilling fluids. The apparatus the patentee calls a thermoheliostat, because it collects the

sun's rays and continuously directs them upon a body placed in or near the focus to which the rays are required to converge, the thermoheliostat being made to keep pace or correspond with the sun's diurnal motion. The patentee proposes to use the thermoheliostat for the purpose of distilling sea water, and obtaining therefrom fresh water; also for boiling and evaporating and generating steam; and for purposes of cooking, especially in tropical climates, and in positions where the sun's heat is great, and where it may be difficult or expensive to procure coal, wood, or other fuel for making a fire, such as at certain lighthouses, in positions little frequented. The patentee states that he prefers reflecting the rays of the sun to refracting them through glass, but describes both.

MACHINE FOR SORTING IVORY COMBS.

In the manufacture of ivory combs the blanks are generally cut of as great length as the width of the elephant's tusks, out of which they are made, admits. Therefore there is always a great variety of lengths, and many of them are so nearly of the same size that it is difficult to detect any difference without comparing them closely, side by side.

It is desirable in putting the combs up in packages of dozens, more or less, to have all the combs in one package of the same size exactly. The only way of sorting them heretofore employed, has been to pick them out by hand, which is a slow and tedious operation, requiring great practice to acquire any considerable degree of skill.

Messrs. Wm. Foskett and Benjamin S. Stedman, of Meriden, Conn., have recently invented a machine which is intended to perform this operation of sorting, with great exactness and despatch. It consists of a round table with a slot or groove cut through around its edge. Said slot is made in flaring form, being wider at one end than the other. The blanks are placed one at a time, across the head or movement part of the slot; there is a pointer in the centre of the table, which then comes around and sweeps the blank along the surface of the slot until a point is reached where the slot is wider than the blank, when it falls through. Boxes are aranged beneath the slot, into which the different sizes fall, and thus are separated.

IMPROVEMENT IN FLUTES.

An improvement in flutes has been recently patented by M. J. Pfaff, which consists in placing the mouth piece of the flute at right angles to the body of the same, so that the instrument may be played upon without the performer twisting his arms and neck into an unnatural position.

NEW METHOD OF MAKING BASKETS.

The following plan of making baskets has been recently patented: — The body of this basket is made entirely of upright splints or staves, without braiding in cross strands. These splints are nearly an eighth of an inch in thickness, and are held firmly in place between the two pieces of thin board that form the bottom and the two hoops that form the top binding or rim, by

wrought nails that pass through each splint and clinch on the inside. The two pieces that form the bottom are placed with the grain of each piece running at right angles across the other, so that when the nails are driven and clinched it prevents their warping or splitting, thus forming a very strong bottom, on which the basket may be dragged about without danger of breaking or wearing out. The rim at the top being fastened with wrought nails that clinch, is very strong, and does not become loose and let the handles slip out. A flexible wire hoop passes around the centre of the basket, which is fastened to each splint, separately, confining them firmly in their places at that point.

PRESERVATION OF WHEAT.

Some time since, under the direction of the French Government, 790 hectolitres (2,175 bushels) of American corn were, by way of experiment, inclosed in two "silos" of sheet iron (large cylinders sunk into the ground, so as to form receptacles for corn, like the corn pits in Algeria) and the covers secured with seals. These latter were recently removed in the presence of two delegates from the War-Office, to which the corn belonged, and of the Commission des Subsistances Militaires, and the corn subjected to a strict examination, when it was pronounced to be in exactly the same state as it was a twelvemonth ago. The cost of preserving corn by means of the "silos" does not exceed 80c. (eight pence) per hectolitre (two and three-quarter bushels.)

A NEW METHOD OF PRESERVING EGGS.

A new method of preserving eggs has been suggested by an English chemist. By coating the shells of fresh laid eggs with mucilage of gum arabic, he has preserved them perfectly good and sweet for several months. In September, 1855, he covered several fresh eggs with two coatings of mucilage, and in March, 1856, six months afterwards, the eggs were boiled, and found to be sweet and good as when newly laid. By this plan eggs may be preserved in summer for use in winter. One coating of the gum arabic should be quite dry before the other is applied. A small brush is best for the purpose of applying it.

SIMPLE CONTRIVANCE FOR TRANSPLANTING TREES.

Take a sheet of iron four feet square and one-eighth of an inch thick. We must suppose one side to be the front; on the front, therefore, rivet two strong iron staples, one near, but not close to each corner. These staples must be cleft to admit and embrace the iron sheet; rivet also two staples behind, so that a horse, or two or three men, may, by means of ropes, drag the contrivance on either side. The tree is to be placed upright on this iron sheet, and fastened to it by cords passed through the four staples; it can now be dragged over the ground without any shaking, and as it slips over the surface without much labor, and as no lifting has been required to place the tree on the carriage, very large balls can be conveyed with the tree, thus lessening the risk of moving. —*Horticulturist.*

EMBOSSED VENEERS.

One of the most useful mechanical processes brought forward of late, is that of embossing veneers for any kind of ornamental wood-work to represent elaborate carvings on wood, and dispensing with that comparatively slow and expensive process. The veneers are prepared according to the inventor's peculiar method, then placed between dies moderately heated, and submitted to pressure. One of the faces of the wood receives the pattern in relief, and gives it the appearance of elaborate wood carving. The depression caused by the dies on the opposite side of the veneer are filled up with a suitable plastic substance; this being dried, the embossed veneer is ready to be glued, or otherwise attached to the furniture.

AUTOMATIC LATHE.

An ingenious and compact automatic lathe, for the production of beaded work of any kind, has recently been invented and patented by G. W. Walton and H. Edgarton, of Wilmington, Delaware.

The cutter head is hollow, and the cutters are mounted in such manner that, by a very simple movement, the edges are removed from, or brought nearer to, the axis of motion, the movement being governed by a cam outside. This cam may be made in any required form, and the configuration and disposition of the beads are thereby under complete control. The lathe executes plain cylindrical and beaded work with great rapidity; all the products cut after the same pattern, being precisely uniform and regular.

IMPROVED BREAD KNEADING MACHINE.

Hard bread or ship biscuit has long been made by machinery, but many unsuccessful attempts have been made to apply it to the preparation of dough for soft or family bread. The failures have been so numerous that it has been considered quite impossible to make mechanical labor a perfect substitute for manual labor in this important branch of bread-making. It was very desirable to accomplish this object under the ordinary system of baking, for the labor of kneading the dough is excessively severe, and the exhausted workman, reeking with perspiration, will often remit his exertions at the very time they should be continued to work the dough effectually, and thus injure the quality of the bread. The defects of machinery applied to this operation have been chopping up the dough, or working it short and heating it so as to kill the life of the flour, instead of preserving a certain continuity of the mass in combination with a thorough mixing process, incorporating the air perfectly, effects which are produced by the violent action of the hands and arms of the workman in punching, squeezing, drawing out and doubling up the dough.

A machine recently invented by Mr. Berdan, of New York City, has been operated most successfully, and, it is thought, will overcome the difficulties heretofore experienced.

It is a stationary cylinder of wood, open on the top, ten feet long by six feet in diameter, in which is a horizontal shaft, so secured that the inside heads of the cylinder revolve with it; and on these heads, extending across near the periphery, are iron bars, varying in form, which have the duty of mixing and thoroughly incorporating the flour and water as they revolve. This part of the operation of kneading is the first in order after the sponge is raised, and is performed by the rotation of the cylinder in a few minutes. After this work is done, another operation commences, which is executed by an additional cross-bar, which is movable and is inserted at the right time. This is a plain plank-shaped affair, which swings on hinges in an eccentric manner, and plunges into the dough at the bottom of the cylinder, cuts off and raises up a portion of the dough till it passes over a certain point, spreading and drawing it out in the act, and then throwing or flapping it down with force, so as to inclose the air and imitate the same motion and result accomplished by the workman with his hands and arms. This movement is continued until the dough is perfectly kneaded, when it is taken out by a trap-door, and the machine is ready to receive another batch.

IMPROVED GAS-BURNERS.

At a recent meeting of the Franklin Institute, Mr. S. S. Garrigues exhibited specimens of bat-wing, fish-tail and Argand burners made of porcelain, the object being to get rid of the rusting, which occurs in metallic burners when exposed, thus preventing a perfect combustion of the gas.

To obviate the corrosion, and expansion of the orifices of gas-burners by heat, he has lately manufactured gas-burners from soapstone (steatite), which is prepared for this purpose in a peculiar manner. This stone is cut up into small four-sided slabs, put into hermetically sealed cases, and exposed to a slow fire until it becomes red hot. Great care is exercised in thus roasting the stone, because if quickly heated, it will rupture by the sudden expansion of small particles of moisture in it. The steatite slabs are exposed to this heat for about two hours, slowly cooled, and are then easily turned to the proper shape in a lathe. After this they are boiled in oil until they acquire a deep brown color, when they are taken out, dried, and made to assume a beautiful polish by simply rubbing them with a woollen rag. The boring of gas-burners is an art requiring great care and skill, as the opening of each burner is formed to consume a certain quantity of gas.

Gas-burners made as described from soapstone are stated to be perfectly fire-proof, and not liable to any change or alteration in the size of the bore or nature of the material by the strongest heat produced by the combustion of the gas. Liebig gives these burners a very high character, and advises all chemists to employ them in their laboratories, as they are not affected by the largest flames to which they may be exposed in applying them to distillation or other methods of analysis, etc.

Batchelder's anti-flickering gas-burner attains its object by means of a circle of minute jets of flame around the light. These create an ascending current that shield it from the cool current as effectually as the glass chimney of the common argand lamp.

MACHINES FOR FELLING TREES.

Two machines, the separate inventions of Messrs. Ingersoll and Ehrsam, are now before the public. Ingersoll's machine weighs one hundred and fifty pounds. The cutting tool is a straight horizontal saw, projecting outside of the frame. By turning a crank, an alternate motion is given to the saw, and it is pressed against the wood by a spring, which has to be wound up from time to time. The machine is placed on the ground on the side of the tree opposite to that on which it has a tendency to fall. The crank is then turned, and, after the entire breadth of the saw is in the wood, a wedge is placed behind in the cut to prevent closing when the tree does not lean on the opposite side. The machine being placed on its side, and spur-wheels being substituted for the bevel wheels which are between the crank and the saw, it is transformed into a machine for sawing logs. Horse power may then be applied to it. Ehrsam's machine is all metal. There is a large ring in two half circles, hinged at one end and keyed at the other, which is placed around the tree and firmly held against it by a few long screws. Inside this ring is another, which, by means of a crown wheel cut in it, and of a pinion, is made to revolve. This second ring carries a gouge or a chisel, extending inside to the tree and advancing to the core when the turning proceeds. A groove is thus cut around the tree, and it is alleged by persons who have experimented with the machine, that the wood will not close on the tool as long as six inches remain uncut. At this stage of the operation the machine is taken away, and the remainder is cut with a hand-saw. It is absolutely necessary with this machine to finish the work by hand; for the tool going around, wedges cannot be placed in the groove to prevent its closing; and if this was obviated by sustaining the tree from the outside, it would break the machine, whatever way it should fall.

CORN HUSKING MACHINES.

John Taggert and L. A. Grover, of Roxbury, Mass., have patented, and are introducing a machine which, at a moderate cost, seems well designed to strip the husks from Indian corn very rapidly and effectually. The husks are loosened by sawing off the butt of the cob, so close as to graze and perhaps nearly destroy the first row of the grain, and the loose husks are then readily removed by teeth projecting up through a grate on which the ears fall. The ears in their natural state are seized and carried through very rapidly and quietly; and the power for the whole is supplied by the foot of the operator.

Another machine, more effectual and ingenious than the above, has also been recently invented by Dr. E. S. Holmes, of Lockport, N. Y. A proper description cannot, however be given of it, without diagrams. It operates not only on the ears broken from the stalks, but also, by attachment to the side of a wagon, it can be made to both pick, husk and place in a receptacle the ears from the stalk standing in the field.

BRITISH ASSOCIATION FOR THE PROMOTION OF SOCIAL SCIENCE.

Among the interesting and important occurrences of the past year, is the successful inauguration in Great Britain of a "National Association for the Promotion of Social Science." The project was due to Lord Brougham, and the initiatory steps for giving it form and substance, were taken at a private meeting at his house, sometime in the spring of last year. The general object of the association is to bring together persons interested in the various plans and studies which have for their end the improvement, progress, or happiness of society, — all philănthropists on a large or small scale, whether dealing with moral, political or material means of influence, for the purpose of bringing their information, their themes, and the results of their investigations to definite and practical uses. The advantage of combined effort in reaching the public mind in such a way as to bring a general influence to bear upon special measures, and in presenting to the legislature those measures prepared in a well-considered, practical, and so to speak an authentic form, are apparent enough. The difficulty of obtaining these advantages by a permanent organization, without wholly covering them up with cumbrous formalities, or losing them in the disputes or jealousies of contending theories, are almost equally manifest.

Notwithstanding the difficulties, the attempt was decided upon, and the organization of the association took place at Birmingham, the first session being held on the evening of the 12th of October, 1857. An inaugural address was delivered by Lord Brougham, the first President of the General Association, which consisted of an able review of what had been done previously for amelioration of society, what remained to be done, and, in a certain sense, the way to do it. He dwelt particularly upon the important beneficial influences upon legislation in Great Britain, which have been produced within the last twenty years, by similar associations of less comprehensive character than that now inaugurated. Of these he instanced with the most particularity, pointing out many marked instances of their usefulness, the Society for the Diffusion of Useful Knowledge, the Society for the Promoting the Amendment of the Law, and the Mercantile Conferences, by which Boards of Trade and Commerce have in several instances had united action, and which have been the means of encouraging the formation and extending the usefulness of those boards. Speaking of the Law Amendment Society, he said: — "Since its establishment in 1844, most of the bills which I have brought forward, and of which many have been passed, making a great change in our jurisprudence, either originated in the inquiries and reports of that society's committees, or owed to the labors and authority of that body valuable help towards, first, their preparation, and then their adoption. . . . . . Of the nine bills which were presented by me to the House of Lords in 1845, and six of which are now the law of the land, two of the six were suggested by the society, and another, the most important of the whole, and which has entirely changed the course of procedure, the Act for the Examination of Parties in all Suits, I never could have succeeded in carrying but for the society's correspondence with all the

county court judges, and their direct unanimous testimony in favor of the change."

On the day after the delivery of this address, the society again met, and several hours were devoted to the inaugural addresses of the "Presidents" of the several departments into which the association had been divided for business purposes. These departments were, *Jurisprudence and Amendment of the Law,* over which Lord John Russell presided; *Education,* Sir J. Pakington; *Punishment and Reformation,* Mr. Hill, Recorder of Birmingham (in the absence of the Bishop of London, who had engaged to preside in that department); *Public Health,* Lord Stanley; *Social Economy,* Sir Benjamin Brodie.

The addresses of these presiding officers were all delivered in the Town Hall, before the whole assembly, before the sections had separated to their several meetings, and were generally, although prepared for delivery to the individual departments to which their respective authors belonged, of a comprehensive though practical character.

The address of Lord Stanley, of the section of public health, abounded in statistics, and in very able deductions drawn from them. These statistics had reference to the conditions of living, dieting, and to the sewage of great towns, — the last a most important question; for at present we really only remove a nuisance from our own locality to fix it in that of a neighbor. Our principle is like that of Mohammedan citizens, who, when suffering from the plague, only implore Allah to remove the pestilence to some other town. The closing portion of the noble Lord's speech is well worthy of being read, *and* remembered. — "Dry and unattractive as sanitary studies may appear, they belong to the patriot no less the philanthropist: they touch very nearly the future prosperity and the national greatness of England. Do not fancy that the mischief done by disease spreading through the community is to be measured by the number of deaths which ensue. That is the least part of the result. As in a battle, the killed bear but a small proportion to the wounded. It is not merely by the crowded hospitals, the frequent funerals, the destitution of families, or the increased pressure of public burdens, that you may test the sufferings of a nation over which sickness has passed. The real and lasting injury lies in the deterioration of race, in the seeds of disease transmitted to future generations, in the degeneracy and decay which are never detected till the evil is irreparable, and of which, even then, the cause remains often undiscovered. It concerns us if the work of England be that of colonization and dominion abroad — if wild hordes and savage races are to be brought by our agency under the influence of civilized man — if we are to maintain peace, to extend commerce, to hold our own among many rivals, alike by arts and arms, — it concerns us, I say, that strong hands shall be forthcoming to wield either sword or spade — that vigorous constitutions be not wanting to endure the vicissitudes of climate and the labors of a settler in a new country. I believe that whatever exceptions may be found in individual instances, when you come to deal with men in the mass, physical and moral decay necessarily go together; and it would be small satisfaction to know that we had through a

series of ages successfully resisted every external agency if we learned too late that that vigor and energy for which ours stands confessedly preëminent among the races of the world were being undermined by a secret but irresistible agency, the offspring of our own neglect, against which science and humanity had warned us in vain."

After the delivery of the inaugural addresses, the association separated into sections, and attended to the reading of papers, and to discussions on appropriate subjects.

NATURAL PHILOSOPHY.

ON THE INTERACTION OF NATURAL FORCES.

The following lecture by Mr. Helmholtz, Professor of Physiology in the university of Bonn, Germany, translated by Professor Tyndall, and published in the London Philosophical Magazine, is an exceedingly interesting contribution to science, and, although of considerable length, will well repay perusal:

A new conquest of very general interest has been recently made by natural philosophy. In the following pages, I will endeavor to give a notion of the nature of this conquest. It has reference to a new and universal natural law, which rules the action of natural forces in their mutual relations towards each other, and is as influential on our theoretic views of natural processes as it is important in their technical applications.

Among the practical arts which owe their progress to the development of the natural sciences, from the conclusion of the middle ages downwards, practical mechanics, aided by the mathematical science which bears the same name, was one of the most prominent. The character of the art was, at the time referred to, naturally very different from its present one. Surprised and stimulated by its own success, it thought no problem beyond its power, and immediately attacked some of the most difficult and complicated. Thus it was attempted to build automaton figures which should perform the functions of men and animals. The wonder of the last century was Vaucanson's duck, which fed and digested its food; the flute-player of the same artist, which moved all its fingers correctly; the writing boy of the older, and the piano-forte player of the younger Droz: which latter, when performing, followed its hands with his eyes, and at the conclusion of the piece bowed courteously to the audience. That men like those mentioned, whose talent might bear comparison with the most inventive heads of the present age, should spend so much time in the construction of these figures, which we at present regard as the merest trifles, would be incomprehensible, if they had not hoped in solemn earnest to solve a great problem. The writing boy of the elder Droz was publicly exhibited in Germany some years ago. Its wheel-work is so complicated, that no ordinary head would be sufficient to decipher its manner of action. When, however, we are informed that this boy and its constructer, being suspected of the black art, lay for a

time in the Spanish Inquisition, and with difficulty obtained their freedom, we may infer that in those days even such a toy appeared great enough to excite doubts as to its natural origin. And though these artists may not have hoped to breathe into the creature of their ingenuity a soul gifted with moral completeness, still there were many who would be willing to dispense with the moral qualities of their servants, if, at the same time, their immoral qualities could also be got rid of; and accept, instead of the mutability of flesh and bones, services which should combine the regularity of a machine with the durability of brass and steel. The object, therefore, which the inventive genius of the past century placed before it with the fullest earnestness, and not as a piece of amusement merely, was boldly chosen, and was followed up with an expenditure of sagacity which has contributed not a little to enrich the mechanical experience which a later time knew how to take advantage of. We no longer seek to build machines which shall fulfil the thousand services required of *one* man, but desire, on the contrary, that a machine shall perform *one* service, but shall occupy in doing it the place of a thousand men.

From these efforts to imitate living creatures, another idea, also by a misunderstanding, seems to have developed itself, which, as it were, formed the new philosopher's stone of the seventeenth and eighteenth centuries. It was now the endeavor to construct a perpetual motion. Under this term was understood a machine, which, without being wound up, without consuming in the working of it, falling water, wind, or any other natural force, should still continue in motion, the motive power being perpetually supplied by the machine itself. Beasts and human beings seemed to correspond to the idea of such an apparatus, for they moved themselves energetically and incessantly as long as they lived, were never wound up, and nobody set them in motion. A connection between the taking-in of nourishment and the development of force did not make itself apparent. The nourishment seemed only necessary to grease, as it were, the wheelwork of the animal machine, to replace what was used up, and to renew the old. The development of force out of itself seemed to be the essential peculiarity, the real quintessence of organic life. If, therefore, men were to be constructed, a perpetual motion must first be found.

Another hope also seemed to take up incidentally the second place, which, in our wiser age, would certainly have claimed the first rank in the thoughts of men. The perpetual motion was to produce work inexhaustibly without corresponding consumption, that is to say, out of nothing. Work, however, is money. Here, therefore, the great practical problem which the cunning heads of all centuries have followed in the most diverse ways, namely, to fabricate money out of nothing, invited solution. The similarity with the philosopher's stone sought by the ancient chemists was complete. That also was thought to contain the quintessence of organic life, and to be capable of producing gold.

The spur which drove men to inquiry was sharp, and the talent of some of the seekers must not be estimated as small. The nature of the problem was quite calculated to entice poring brains, to lead them round a circle for

years, deceiving ever with new expectations, which vanished upon nearer approach, and finally reducing these dupes of hope to open insanity. The phantom could not be grasped. It would be impossible to give a history of these efforts, as the clearer heads, among whom the elder Droz must be ranked, convinced themselves of the futility of their experiments, and were naturally not inclined to speak much about them. Bewildered intellects, however, proclaimed often enough that they had discovered the grand secret; and as the incorrectness of their proceedings was always speedily manifest, the matter fell into bad repute, and the opinion strengthened itself more and more that the problem was not capable of solution; one difficulty after another was brought under the dominion of mathematical mechanics, and finally a point was reached where it could be proved, that, at least, by the use of pure mechanical forces, no perpetual motion could be generated.

We have here arrived at the idea of the driving force or power of a machine, and shall have much to do with it in future. I must, therefore, give an explanation of it. The idea of work is evidently transferred to machines by comparing their arrangements with those of men and animals, to replace which they were applied. We still reckon the work of steam engines according to horse-power. The value of manual labor is determined partly by the force which is expended in it (a strong laborer is valued more highly than a weak one), partly, however, by the skill which is brought into action. A machine, on the contrary, which executes work skilfully, can always be multiplied to any extent; hence its skill has not the high value of human skill in domains where the latter cannot be supplied by machines. Thus the idea of the quantity of work in the case of machines has been limited to the consideration of the expenditure of force; this was the more important, as indeed most machines are constructed for the express purpose of exceeding, by the magnitude of their effects, the powers of men and animals. Hence, in a mechanical sense, the idea of work is become identical with that of the expenditure of force, and in this way I will apply it.

How, then, can we measure this expenditure, and compare it in the case of different machines?

I must here conduct you a portion of the way — as short a portion as possible — over the uninviting field of mathematico-mechanical ideas, in order to bring you to a point of view from which a more rewarding prospect will open. And though the example which I shall here choose, namely, that of a water-mill with iron hammer, appears to be tolerably romantic, still, alas, I must leave the dark forest valley, the spark-emitting anvil, and the black Cyclops wholly out of sight, and beg a moment's attention to the less poetic side of the question, namely, the machinery. This is driven by a water-wheel, which in its turn is set in motion by the falling water. The axle of the water-wheel has at certain places small projections, thumbs, which, during the rotation, lift the heavy hammer and permit it to fall again. The falling hammer belabors the mass of metal, which is introduced beneath it. The work therefore done by the machine consists, in this case, in the lifting of the hammer, to do which the gravity of the latter must be overcome. The

expenditure of force will, in the first place, other circumstances being equal, be proportional to the weight of the hammer; it will, for example, be double when the weight of the hammer is doubled. But the action of the hammer depends not upon its weight alone, but also upon the height from which it falls. If it falls through two feet, it will produce a greater effect than if it falls through only one foot. It is, however, clear that if the machine, with a certain expenditure of force, lifts the hammer a foot in height, the same amount of force must be expended to raise it a second foot in height. The work is therefore not only doubled when the weight of the hammer is increased twofold, but also when the space through which it falls is doubled. From this it is easy to see that the work must be measured by the product of the weight into the space through which it ascends. And in this way, indeed, do we measure in mechanics.

The unit of work is a foot-pound, that is, a pound weight raised to the height of one foot.

While the work in this case consists in the raising of the heavy hammer-head, the driving force which sets the latter in motion, is generated by falling water. It is not necessary that the water should fall vertically, it can also flow in a moderately inclined bed; but it must always, where it has water-mills to set in motion, move from a higher to a lower position. Experiment and theory coincide in teaching, that when a hammer of a hundred weight is to be raised one foot, to accomplish this at least a hundred weight of water must fall through the space of one foot; or what is equivalent to this, two hundred weight must fall half a foot, or four hundred weight a quarter of a foot, etc. In short, if we multiply the weight of the falling water by the height through which it falls, and regard, as before, the product as the measure of the work, then the work performed by the machine in raising the hammer, can, in the most favorable case, be only equal to the number of foot-pounds of water which have fallen in the same time. In practice, indeed, this ratio is by no means attained; a great portion of the work of the falling water escapes unused, inasmuch as part of the force is willingly sacrificed for the sake of obtaining greater speed.

I will further remark, that this relation remains unchanged whether the hammer is driven immediately by the axle of the wheel, or whether — by the intervention of wheel-work, endless screws, pulleys, ropes — the motion is transferred to the hammer. We may, indeed, by such arrangements, succeed in raising a hammer of ten hundred weight, when by the first simple arrangement, the elevation of a hammer one hundred weight might alone be possible; but either this heavier hammer is raised to only one tenth of the height, or tenfold the time is required to raise it to the same height; so that, however we may alter, by the interposition of machinery, the intensity of the acting force, still in a certain time, during which the mill-stream furnishes us with a definite quantity of water, a certain definite quantity of work, and no more, can be performed.

Our machinery, therefore, has, in the first place, done nothing more than make use of the gravity of the falling water in order to overpower the gravity of the hammer, and to raise the latter. When it has lifted the hammer to

the necessary height, it again liberates it, and the hammer falls upon the metal mass which is pushed beneath it. But why does the falling hammer here exercise a greater force than when it is permitted simply to press with its own weight on the mass of metal? Why is its power greater as the height from which it falls is increased? We find, in fact, that the work performed by the hammer is determined by its velocity. In other cases, also, the velocity of moving masses is a means of producing great effects. I only remind you of the destructive effects of musket-bullets, which, in a state of rest, are the most harmless things in the world. I remind you of the windmill, which derives its force from the moving air. It may appear surprising that motion, which we are accustomed to regard as a non-essential and transitory endowment of bodies, can produce such great effects. But the fact is, that motion appears to us, under ordinary circumstances, transitory, because the movement of all terrestrial bodies is resisted perpetually by other forces, friction, resistance of the air, etc., so that motion is incessantly weakened and finally neutralized. A body, however, which is opposed by no resisting force, when once set in motion, moves onwards eternally with undiminished velocity. Thus we know that the planetary bodies have moved without change, through space, for thousands of years. Only by resisting forces can motion be diminished or destroyed. A moving body, such as the hammer or the musket-ball, when it strikes against another, presses the latter together, or penetrates it, until the sum of the resisting forces which the body struck presents to its pressure, or to the separation of its particles, is sufficiently great to destroy the motion of the hammer or of the bullet. The motion of a mass regarded as taking the place of working force is called the living force (*vis viva*) of the mass. The word "living" has of course here no reference whatever to living beings, but is intended to represent solely the force of the motion as distinguished from the state of unchanged rest—from the gravity of a motionless body, for example, which produces an incessant pressure against the surface which supports it, but does not produce any motion.

In the case before us, therefore, we had first power in the form of a falling mass of water, then in the form of a lifted hammer, and, thirdly, in the form of the living force of the fallen hammer. We should transform the third form into the second, if we, for example, permitted the hammer to fall upon a highly elastic steel beam strong enough to resist the shock. The hammer would rebound, and in the most favorable case would reach a height equal to that from which it fell, but would never rise higher. In this way its mass would ascend: and at the moment when its highest point has been attained, it would represent the same number of raised foot-pounds as before it fell, never a greater number; that is to say, living force can generate the same amount of work as that expended in its production. It is therefore equivalent to this quantity of work.

Our clocks are driven by means of sinking weights, and our watches by means of the tension of springs. A weight which lies on the ground, an elastic spring which is without tension, can produce no effects; to obtain such we must first raise the weight or impart tension to the spring, which is

accomplished when we wind up our clocks and watches. The man who winds the clock or watch communicates to the weight or to the spring a certain amount of power, and exactly so much as is thus communicated is gradually given out again during the following twenty-four hours, the original force being thus slowly consumed to overcome the friction of the wheels and the resistance which the pendulum encounters from the air. The wheel-work of the clock therefore exhibits no working force which was not previously communicated to it, but simply distributes the force given to it uniformly over a longer time.

Into the chamber of an air-gun we squeeze, by means of a condensing air-pump, a great quantity of air. When we afterwards open the cock of a gun and admit the compressed air into the barrel, the ball is driven out of the latter with a force similar to that exerted by ignited powder. Now we may determine the work consumed in the pumping-in of the air, and the living force which, upon firing, is communicated to the ball, but we shall never find the latter greater than the former. The compressed air has generated no working force, but simply gives to the bullet that which has been previously communicated to it. And while we have pumped for perhaps a quarter of an hour to charge the gun, the force is expended in a few seconds when the bullet is discharged; but because the action is compressed into so short a time, a much greater velocity is imparted to the ball than would be possible to communicate to it by the unaided effort of the arm in throwing it.

From these examples you observe, and the mathematical theory has corroborated this for all purely mechanical, that is to say, for moving forces, that all our machinery and apparatus generate no force, but simply yield up the power communicated to them by natural forces, — falling water, moving wind, or by the muscles of men and animals. After this law had been established by the great mathematicians of the last century, a perpetual motion, which should only make use of pure mechanical forces, such as gravity, elasticity, pressure of liquids and gases, could only be sought after by bewildered and ill-instructed people. But there are still other natural forces which are not reckoned among the purely moving forces, — heat, electricity, magnetism, light, chemical forces, all of which nevertheless stand in manifold relation to mechanical processes. There is hardly a natural process to be found which is not accompanied by mechanical actions, or from which mechanical work may not be derived. Here the question of a perpetual motion remained open; the decision of this question marks the progress of modern physics.

In the case of the air-gun, the work to be accomplished in the propulsion of the ball was given by the arm of the man who pumped in the air. In ordinary firearms, the condensed mass of air which propels the bullet is obtained in a totally different manner, namely, by the combustion of the powder. Gunpowder is transformed by combustion for the most part into gaseous products, which endeavor to occupy a much larger space than that previously taken up by the volume of the powder. Thus, you see, that, by the use of gunpowder, the work which the human arm must accomplish in the case of the air-gun is spared.

In the mightiest of our machines, the steam engine, it is a strongly compressed aëriform body, water vapor, which, by its effort to expand, sets the machine in motion. Here also we do not condense the steam by means of an external mechanical force, but by communicating heat to a mass of water in a closed boiler, we change this water into steam, which, in consequence of the limits of the space, is developed under strong pressure. In this case, therefore, it is the heat communicated which generates the mechanical force. The heat thus necessary for the machine we might obtain in many ways; the ordinary method is to procure it from the combustion of coal.

Combustion is a chemical process. A particular constituent of our atmosphere, oxygen, possesses a strong force of attraction, or, as it is named in chemistry, a strong affinity for the constituents of the combustible body, which affinity, however, in most cases, can only exert itself at high temperatures. As soon as a portion of the combustible body, for example the coal, is sufficiently heated, the carbon unites itself with great violence to the oxygen of the atmosphere and forms a peculiar gas, carbonic acid, the same which we see foaming from beer and champagne. By this combination, light and heat are generated; heat is generally developed by any combination of two bodies of strong affinity for each other; and when the heat is intense enough, light appears. Hence, in the steam engine, it is chemical processes and chemical forces which produce the astonishing work of these machines. In like manner the combustion of gunpowder is a chemical process, which, in the barrel of the gun, communicates living force to the bullet.

While now the steam engine develops for us mechanical work out of heat, we can conversely generate heat by mechanical forces. A skilful blacksmith can render an iron wedge red hot by hammering. The axles of our carriages must be protected, by careful greasing, from ignition through friction. Even lately this property has been applied on a large scale. In some factories, where a surplus of water power is at hand, this surplus is applied to cause a strong iron plate to rotate swiftly upon another, so that they become strongly heated by the friction. The heat so obtained warms the room, and thus a stove without fuel is provided. Now, could not the heat generated by the plates be applied to a small steam engine, which, in its turn, should be able to keep the rubbing plates in motion? The perpetual motion would thus be at length found. This question might be asked, and could not be decided by the older mathematico-mechanical investigations. I will remark, beforehand, that the general law which I will lay before you answers the question in the negative.

By a similar plan, however, a speculative American set some time ago the industrial world of Europe in excitement. The magneto-electric machines often made use of in the case of rheumatic disorders are well known to the public. By imparting a swift rotation to the magnet of such a machine, we obtain powerful currents of electricity. If those be conducted through water, the latter will be reduced into its two components, oxygen and hydrogen. By the combustion of hydrogen, water is again generated. If this combustion takes place, not in atmospheric air, of which oxygen only constitutes a fifth part, but in pure oxygen, and if a bit of chalk be placed in

the flame, the chalk will be raised to a white heat, and give us the sun-like Drummond's light. At the same time, the flame develops a considerable quantity of heat. Our American proposed to utilize in this way the gases obtained from electrolytic decomposition, and asserted that by the combustion a sufficient amount of heat was generated to keep a small steam engine in action, which again drove his magneto-electric machine, decomposed the water, and thus continually prepared its own fuel. This would certainly have been the most splendid of all discoveries; a perpetual motion which, besides the force that kept it going, generated light like the sun, and warmed all around it. The matter was by no means badly cogitated. Each practical step in the affair was known to be possible; but those which at that time were acquainted with the physical investigations which bear upon this subject could have affirmed, on first hearing the report, that the matter was to be numbered among the numerous stories of the fable-rich America; and, indeed, a fable it remained.

It is not necessary to multiply examples further. You will infer from those given, in what immediate connection heat, electricity, magnetism, light, and chemical affinity, stand with mechanical forces.

Starting from each of these different manifestations of natural forces, we can set every other in motion, for the most part not in one way merely, but in many ways. It is here as with the weaver's web,—

> Where a step stirs a thousand threads,
> The shuttles shoot from side to side,
> The fibres flow unseen,
> And one shock strikes a thousand combinations.

Now it is clear that if by any means we could succeed, as the above American professed to have done, by mechanical forces, to excite chemical, electrical, or other natural processes, which, by any circuit whatever, and without altering permanently the active masses in the machine, could produce mechanical force in greater quantity than that at first applied, a portion of the work thus gained might be made use of to keep the machine in motion, while the rest of the work might be applied to any other purpose whatever. The problem was, to find in the complicated net of reciprocal actions, a track through chemical, electrical, magnetical, and thermic processes, back to mechanical actions, which might be followed with a final gain of mechanical work; thus would the perpetual motion be found.

But, warned by the futility of former experiments, the public had become wiser. On the whole, people did not seek much after combinations which promised to furnish a perpetual motion, but the question was inverted. It was no more asked, How can I make use of the known and unknown relations of natural forces so as to construct a perpetual motion? but it was asked, If a perpetual motion be impossible, what are the relations which must subsist between natural forces? Everything was gained by this inversion of the question. The relations of natural forces rendered necessary by the above assumption, might be easily and completely stated. It was found that all known relations of forces harmonize with the consequences of that

assumption, and a series of unknown relations were discovered at the same time, the correctness of which remained to be proved. If a single one of them could be proved false, then a perpetual motion would be possible.

The first who endeavored to travel this way was a Frenchman, named Carnot, in the year 1824. In spite of a too limited conception of his subject, and an incorrect view as to the nature of heat, which led him to some erroneous conclusions, his experiment was not quite unsuccessful. He discovered a law which now bears his name, and to which I will return further on.

His labors remained for a long time without notice, and it was not till eighteen years afterwards, that is, in 1842, that different investigators in different countries, and independent of Carnot, laid hold of the same thought.

The first who saw truly the general law here referred to, and expressed it correctly, was a German physician, J. R. Mayer, of Heilbronn, in the year 1842. A little later, in 1843, a Dane, named Colding, presented a memoir to the Academy of Copenhagen, in which the same law found utterance, and some experiments were described for its further corroboration. In England, Joule began about the same time to make experiments having reference to the same subject. We often find, in the case of questions to the solution of which the development of science points, that several heads, quite independent of each other, generate exactly the same series of reflections.*

I myself, without being acquainted with either Mayer or Colding, and having first made the acquaintance of Joule's experiments at the end of my investigation, followed the same path. I endeavored to ascertain all the relations between the different natural processes, which followed from our regarding them from the above point of view. My inquiry was made public in 1847, in a small pamphlet bearing the title, "On the Conservation of Force."

Since that time the interest of the scientific public for this subject has gradually augmented. A great number of the essential consequences of the above manner of viewing the subject, the proof of which was wanting when the first theoretic notions were published, have since been confirmed

* The following extract is taken from a lecture by Mr. Grove, delivered at the London Institution, on the 19th of January, 1842: —

"Light, heat, electricity, magnetism, motion, and chemical affinity, are all convertible material affections; assuming any one as a cause, one of the others will be the effect. Thus heat may be said to produce electricity, electricity to produce heat; magnetism to produce electricity, electricity magnetism; and so of the rest. Cause and effect, therefore, in their relation to such forces, are words solely of convenience; we are totally unacquainted with the generating power of each and all of them, and probably shall ever remain so; we can only ascertain the normal of their action; we must humbly refer their causation to one omnipresent influence, and content ourselves with studying their effects, and developing by experiment their mutual relations."

"I have long held an opinion," says Mr. Faraday, in 1845, "almost amounting to conviction, in common I believe with many other lovers of natural knowledge, that the various forms under which the forces of matter are made manifest have a common origin, or in other words, are so directly related and mutually dependent, that they are convertible one into another."

by experiment, particularly by those of Joule; and during the last year the most eminent physicist of France, Regnault, has adopted the new mode of regarding the question, and by fresh investigations on the specific heat of gases has contributed much to its support. For some important consequences the experimental proof is still wanting, but the number of confirmations is so predominant, that I have not deemed it too early to bring the subject before even a non-scientific audience.

How the question has been decided you may already infer from what has been stated. In the series of natural processes there is no circuit to be found, by which mechanical force can be gained without a corresponding consumption. The perpetual motion remains impossible. Our reflections, however, gain thereby a higher interest.

We have thus far regarded the development of force by natural processes, only in its relation to its usefulness to man, as mechanical force. You now see that we have arrived at a general law, which holds good wholly independent of the application which man makes of natural forces; we must therefore make the expression of our law correspond to this more general significance. It is in the first place clear, that the work which, by any natural process whatever, is performed under favorable conditions by a machine, and which may be measured in the way already indicated, may be used as a measure of force common to all. Further, the important question arises, "If the quantity of force cannot be augmented except by corresponding consumption, can it be diminished or lost? For the purposes of our machines it certainly can, if we neglect the opportunity to convert natural processes to use, but as investigation has proved, not for a nature as a whole."

In the collision and friction of bodies against each other, the mechanics of former years assumed simply that living force was lost. But I have already stated that each collision and each act of friction generates heat; and, moreover, Joule has established by experiment the important law, that for every foot-pound of force which is lost, a definite quantity of heat is always generated, and that when work is performed by the consumption of heat, for each foot-pound thus gained a definite quantity of heat disappears. The quantity of heat necessary to raise the temperature of a pound of water a degree of the centigrade thermometer, corresponds to a mechanical force by which a pound weight would be raised to the height of 1,350 feet; we name this quantity the mechanical equivalent of heat. I may mention here that these facts conduct of necessity to the conclusion, that heat is not, as was formerly imagined, a fine imponderable substance, but that, like light, it is a peculiar shivering motion of the ultimate particles of bodies. In collision and friction, according to this manner of viewing the subject, the motion of the mass of a body which is apparently lost is converted into a motion of the ultimate particles of the body; and conversely, when mechanical force is generated by heat, the motion of the ultimate particles is converted into a motion of the mass.

Chemical combinations generate heat, and the quantity of this heat is totally independent of the time and steps through which the combination

has been effected, provided that other actions are not at the same time brought into play. If, however, mechanical work is at the same time accomplished, as in the case of the steam engine, we obtain as much less heat as is equivalent to this work. The quantity of work produced by chemical force is in general very great. A pound of the purest coal gives, when burnt, sufficient heat to raise the temperature of 8,086 pounds of water one degree of the centigrade thermometer; from this we can calculate that the magnitude of the chemical force of attraction between the particles of a pound of coal and the quantity of oxygen that corresponds to it, is capable of lifting a weight of one hundred pounds to a height of twenty miles. Unfortunately, in our steam engines, we have hitherto been able to gain only the smallest portion of this work; the greater part is lost in the shape of heat. The best expansive engines give back as mechanical work only eighteen per cent. of the heat generated by the fuel.

From a similar investigation of all the other known physical and chemical processes, we arrive at the conclusion that Nature as a whole possesses a store of force which cannot in any way be either increased or diminished, and that, therefore, the quantity of force in nature is just as eternal and unalterable as the quantity of matter. Expressed in this form, I have named the general law "The Principle of the Conservation of Force."

We cannot create mechanical force, but we may help ourselves from the general store-house of Nature. The brook and the wind, which drive our mills, the forest and the coal-bed, which supply our steam engines and warm our rooms, are to us the bearers of a small portion of the great natural supply which we draw upon for our purposes, and the actions of which we can apply as we think fit. The possessor of a mill claims the gravity of the descending rivulet, or the living force of the moving wind, as his possession. These portions of the store of Nature are what give his property its chief value.

Further, from the fact that no portion of force can be absolutely lost, it does not follow that a portion may not be inapplicable to human purposes. In this respect the inferences drawn by William Thomson from the law of Carnot are of importance. This law, which was discovered by Carnot during his endeavors to ascertain the relations between heat and mechanical force, which, however, by no means belongs to the necessary consequences of the conservation of force, and which Clausius was the first to modify in such a manner that it no longer contradicted the above general law, expresses a certain relation between the compressibility, the capacity for heat, and the expansion by heat of all bodies. It is not yet considered as actually proved, but some remarkable deductions having been drawn from it, and afterwards proved to be facts by experiment, it has attained thereby a great degree of probability. Besides the mathematical form in which the law was first expressed by Carnot, we can give it the following more general expression:—"Only when heat passes from a warmer to a colder body, and even then only partially, can it be converted into mechanical work."

The heat of a body which we cannot cool further, cannot be changed into another form of force; into the electric or chemical force, for example.

Thus, in our steam engines, we convert a portion of the heat of the glowing coal into work, by permitting it to pass to the less warm water of the boiler. If, however, all the bodies in nature had the same temperature, it would be impossible to convert any portion of their heat into mechanical work. According to this, we can divide the total force store of the universe into two parts, one of which is heat, and must continue to be such; the other, to which a portion of the heat of the warmer bodies, and the total supply of chemical, mechanical, electrical, and magnetical forces belong, is capable of the most varied changes of form, and constitutes the whole wealth of change which takes place in nature.

But the heat of the warmer bodies strives perpetually to pass to bodies less warm by radiation and conduction, and thus to establish an equilibrium of temperature. At each motion of a terrestrial body, a portion of mechanical force passes by friction or collision into heat, of which only a part can be converted back again into mechanical force. This is also generally the case in every electrical and chemical process. From this, it follows that the first portion of the store of force, the unchangeable heat, is augmented by every natural process, while the second portion, mechanical, electrical, and chemical force, must be diminished; so that if the universe be delivered over to the undisturbed action of its physical processes, all force will finally pass into the form of heat, and all heat come into a state of equilibrium. Then all possibility of a further change would be at an end, and the complete cessation of all natural processes must set in. The life of men, animals, and plants, could not of course continue if the sun had lost its high temperature, and with it his light, — if all the components of the earth's surface had closed those combinations which their affinities demand. In short, the universe from that time forward would be condemned to a state of eternal rest.

These consequences of the law of Carnot are, of course, only valid, provided that the law, when sufficiently tested, proves to be universally correct. In the mean time there is little prospect of the law being proved incorrect. At all events we must admire the sagacity of Thomson, who, in the letters of a long known little mathematical formula, which only speaks of the heat, volume, and pressure of bodies, was able to discern consequences which threatened the universe, though certainly after an infinite period of time, with eternal death.

I have already given you notice that our path lay through a thorny and unrefreshing field of mathematico-mechanical developments. We have now left this portion of our road behind us. The general principle which I have sought to lay before you has conducted us to a point from which our view is a wide one, and, aided by this principle, we can now at pleasure regard this or the other side of the surrounding world, according as our interest in the matter leads us. A glance into the narrow laboratory of the physicist, with its small appliances and complicated abstractions, will not be so attractive as a glance at the wide heaven above us, the clouds, the rivers, the woods, and the living beings around us. While regarding the laws which have been deduced from the physical processes of terrestrial bodies, as

applicable also to the heavenly bodies, let me remind you that the same force which, acting at the earth's surface, we call gravity, (*Schwere*) acts as gravitation in the celestial spaces, and also manifests its power in the motion of the immeasurably distant double stars which are governed by exactly the same laws as those subsisting between the earth and moon; that, therefore, the light and heat of terrestrial bodies do not in any way differ essentially from those of the sun, or of the most distant fixed star; that the meteoric stones which sometimes fall from external space upon the earth are composed of exactly the same simple chemical substances as those with which we are acquainted. We need, therefore, feel no scruple in granting that general laws to which all terrestrial natural processes are subject, are also valid for other bodies than the earth. We will, therefore, make use of our law to glance over the household of the universe with respect to the store of force, capable of action, which it possesses.

A number of singular peculiarities in the structure of our planetary system indicate that it was once a connected mass with a uniform motion of rotation. Without such an assumption it is impossible to explain why all the planets move in the same direction round the sun, why they all rotate in the same direction round their axes, why the planes of their orbits, and those of their satellites and rings all nearly coincide, why all their orbits differ but little from circles, and much besides. From these remaining indications of a former state, astronomers have shaped an hypothesis regarding the formation of our planetary system, which, although from the nature of the case it must ever remain an hypothesis, still in its special traits is so well supported by analogy, that it certainly deserves our attention. It was Kant, who, feeling great interest in the physical description of the earth and the planetary system, undertook the labor of studying the works of Newton, and as an evidence of the depth to which he had penetrated into the fundamental ideas of Newton, seized the notion that the same attractive force of all ponderable matter which now supports the motion of the planets, must also aforetime have been able to form from matter loosely scattered in space the planetary system. Afterwards, and independent of Kant, Laplace, the great author of the *Mécanique Céleste,* laid hold of the same thought, and introduced it among astronomers.

The commencement of our planetary system, including the sun, must, according to this, be regarded as an immense nebulous mass which filled the portion of space which is now occupied by our system, far beyond the limits of Neptune, our most distant planet. Even now we perhaps see similar masses in the distant regions of the firmament, as patches of nebulæ, and nebulous stars; within our system also, comets, the zodiacal light, the corona of the sun during a total eclipse, exhibit remnants of a nebulous substance, which is so thin that the light of the stars passes through it unenfeebled and unrefracted. If we calculate the density of the mass of our planetary system, according to the above assumption, for the time when it was a nebulous sphere, which reached to the path of the outmost planet, we should find that it would require several cubic miles of such matter to weigh a single grain.

The general attractive force of all matter must, however, impel these masses to approach each other, and to condense, so that the nebulous sphere became incessantly smaller, by which, according to mechanical laws, a motion of rotation originally slow, and the existence of which must be assumed, would gradually become quicker and quicker. By the centrifugal force which must act most energetically in the neighborhood of the equator of the nebulous sphere, masses could from time to time be torn away, which afterwards would continue their courses separate from the main mass, forming themselves into single planets, or, similar to the great original sphere, into planets with satellites and rings, until finally the principal mass condensed itself into the sun. With regard to the origin of heat and light, this view gives us no information.

When the nebulous chaos first separated itself from other fixed star masses, it must not only have contained all kinds of matter which was to constitute the future planetary system, but also, in accordance with our new law, the whole store of force which at one time must unfold therein its wealth of actions. Indeed in this respect an immense dower was bestowed in the shape of the general attraction of all the particles for each other. This force, which on the earth exerts itself as gravity, acts in the heavenly spaces as gravitation. As terrestrial gravity when it draws a weight downwards performs work and generates *vis viva*, so also the heavenly bodies do the same when they draw two portions of matter from distant regions of space towards each other.

The chemical forces must have been also present, ready to act; but as these forces can only come into operation by the most intimate contact of the different masses, condensation must have taken place before the play of chemical forces began.

Whether a still further supply of force in the shape of heat was present at the commencement we do not know. At all events, by aid of the law of the equivalence of heat and work, we find in the mechanical forces, existing at the time to which we refer, such a rich source of heat and light, that there is no necessity whatever to take refuge in the idea of a store of these forces originally existing. When through condensation of the masses their particles came into collision, and clung to each other, the *vis viva* of their motion would be thereby annihilated, and must reappear as heat. Already in old theories, it has been calculated, that cosmical masses must generate heat by their collision, but it was far from any body's thought, to make even a guess at the amount of heat to be generated in this way. At present we can give definite numerical values with certainty.

Let us make this addition to our assumption; that, at the commencement, the density of the nebulous matter was a vanishing quantity, as compared with the present density of the sun and planets; we can then calculate how much work has been performed by the condensation; we can further calculate how much of this work still exists in the form of mechanical force, as attraction of the planets towards the sun, and as *vis viva* of their motion, and find, by this, how much of the force has been converted into heat.

The result of this calculation is, that only about the 454th part of the

original mechanical force remains as such, and that the remainder, converted into heat, would be sufficient to raise a mass of water equal to the sun and planets taken together, not less than twenty-eight millions of degrees of the centigrade scale. For the sake of comparison, I will mention that the highest temperature which we can produce by the oxyhydrogen blowpipe, which is sufficient to fuse and vaporize even platina, and which but few bodies can endure, is estimated at about two thousand centigrade degrees. Of the action of a temperature of twenty-eight millions of such degrees we can form no notion. If the mass of our entire system were pure coal, by the combustion of the whole of it only the 3500th part of the above quantity would be generated. This is also clear, that such a development of heat must have presented the greatest obstacle to the speedy union of the masses, that the larger part of the heat must have been diffused by radiation into space, before the masses could form bodies possessing the present density of the sun and planets, and that these bodies must once have been in a state of fiery fluidity. This notion is corroborated by the geological phenomena of our planet; and with regard to the other planetary bodies, the flattened form of the sphere, which is the form of equilibrium of a fluid mass, is indicative of a former state of fluidity. If I thus permit an immense quantity of heat to disappear without compensation from our system, the principle of the conservation of force is not thereby invaded. Certainly for our planet it is lost, but not for the universe. It has proceeded outwards, and daily proceeds outwards into infinite space; and we know not whether the medium which transmits the undulations of light and heat possesses an end where the rays must return, or whether they eternally pursue their way through infinitude.

The store of force at present possessed by our system, is also equivalent to immense quantities of heat. If our earth were by a sudden shock brought to rest on her orbit — which is not to be feared in the existing arrangements of our system — by such a shock a quantity of heat would be generated equal to that produced by the combustion of fourteen such earths of solid coal. Making the most unfavorable assumption as to its capacity for heat, that is, placing it equal to that of water, the mass of the earth would thereby be heated 11,200 degrees; it would therefore be quite fused and for the most part reduced to vapor. If, then, the earth, after having been thus brought to rest, should fall into the sun, which of course would be the case, the quantity of heat developed by the shock would be four hundred times greater.

Even now, from time to time, such a process is repeated on a small scale. There can hardly be a doubt that meteors, fire-balls, and meteoric stones, are masses which belong to the universe, and before coming into the domain of our earth, moved like the planets round the sun. Only when they enter our atmosphere do they become visible and fall sometimes to the earth. In order to explain the emission of light by these bodies, and the fact that for some time after their descent they are very hot, the friction was long ago thought of which they experience in passing through the air. We can now calculate that a velocity of 3,000 feet a second, supposing the whole of the

friction to be expended in heating the solid mass, would raise a piece of meteoric iron 1,000° C. in temperature or, in other words, to a vivid red heat. Now the average velocity of the meteors seems to be thirty or forty times the above amount. To compensate this, however, the greater portion of the heat is, doubtless, carried away by the condensed mass of air which the meteor drives before it. It is known that bright meteors generally leave a luminous trail behind them, which probably consists of severed portions of the red-hot surfaces. Meteoric masses which fall to the earth often burst with a violent explosion, which may be regarded as a result of the quick heating. The newly-fallen pieces have been for the most part found hot, but not red-hot, which is easily explainable by the circumstance, that during the short time occupied by the meteor in passing through the atmosphere, only a thin, superficial layer is heated to redness, while but a small quantity of heat has been able to penetrate to the interior of the mass. For this reason the red heat can speedily disappear.

Thus has the falling of the meteoric stone, the minute remnant of processes which seem to have played an important part in the formation of the heavenly bodies, conducted us to the present time, where we pass from the darkness of hypothetical views to the brightness of knowledge. In what we have said, however, all that is hypothetical is the assumption of Kant and Laplace, that the masses of our system were once distributed as nebulæ in space.

On account of the rarity of the case, we will still further remark, in what close coincidence the results of science here stand with the earlier legends of the human family, and the forebodings of poetic fancy. The cosmogony of ancient nations generally commences with chaos and darkness.

Neither is the Mosaic tradition very divergent, particularly when we remember that that which Moses names heaven is different from the blue dome above us, and is synonymous with space, and that the unformed earth, and the waters of the great deep, which were afterwards divided into waters above the firmament, and waters below the firmament, resembled the chaotic components of the world.

Our earth bears still the unmistakable traces of its old fiery fluid condition. The granite formations of her mountains exhibit a structure, which can only be produced by the crystallization of fused masses. Investigation still shows that the temperature in mines, and borings, increases as we descend; and if this increase is uniform, at the depth of fifty miles, a heat exists sufficient to fuse all our minerals.* Even now our volcanoes project, from time to time, mighty masses of fused rocks from their interior, as a testimony of the heat which exists there. But the cooled crust of the earth has already become so thick, that, as may be shown by calculations of its conductive power, the heat coming to the surface from within, in comparison with that reaching the earth from the sun, is exceedingly small, and in-

* This is not probable. The greater density and consequent better conductivity of the mass, and the elevation of the point of fusion by pressure established by the researches of Messrs. Hopkins and Fairbairn, would throw the region of liquidity deeper.

creases the temperature of the surface only about one thirtieth of a degree centigrade; so that the remnant of the old store of force which is enclosed as heat within the bowels of the earth, has a sensible influence upon the processes at the earth's surface, only through the instrumentality of volcanic phenomena. *These processes owe their power almost wholly to the action of other heavenly bodies, particularly to the light and heat of the sun, and partly also, in the case of the tides, to the attraction of the sun and moon.*

Most varied and numerous are the changes which we owe to the light and heat of the sun. The sun heats our atmosphere irregularly, the warm rarefied air ascends, while fresh cool air flows from the sides to supply its place: in this way winds are generated. This action is most powerful at the equator, the warm air of which incessantly flows in the upper regions of the atmosphere towards the poles: while just as persistently, at the earth's surface, the trade wind carries new and cool air to the equator. Without the heat of the sun all winds must, of necessity, cease. Similar currents are produced by the same cause in the waters of the sea. Their power may be inferred from the influence which in some cases they exert upon climate. By them the warm water of the Antilles is carried to the British Isles, and confers upon them a mild, uniform warmth and rich moisture; while, through similar causes, the floating ice of the North Pole is carried to the coast of Newfoundland, and produces cold. Further, by the heat of the sun, a portion of the water is converted into vapor, which rises in the atmosphere, is condensed to clouds, or falls in rain and snow upon the earth, collects in the form of springs, brooks, and rivers, and finally reaches the sea again, after having gnawed the rocks, carried away the light earth, and thus performed its part in the geologic changes of the earth; perhaps, besides all this it has driven our water-mill upon its way. If the heat of the sun were withdrawn, there would remain only a single motion of water, namely, the tides, which are produced by the attraction of the sun and moon.

How is it, now, with the motions and the work of organic beings. To the builders of the automata of the last century, men and animals appeared as clockwork which was never wound up, and created the force which they exerted out of nothing. They did not know how to establish a connection between the nutriment consumed and the work generated. Since, however, we have learned to discern in the steam-engine this origin of mechanical force, we must inquire whether something similar does not hold good with regard to men. Indeed, the continuation of life is dependent on the consumption of nutritive materials: these are combustible substances, which, after digestion and being passed into the blood, actually undergo a slow combustion, and finally enter into almost the same combinations with the oxygen of the atmosphere that are produced in an open fire. As the quantity of heat generated by combustion is independent of the duration of the combustion and the steps in which it occurs, we can calculate from the mass of the consumed material how much heat, or its equivalent work is thereby generated in an animal body. Unfortunately, the difficulty of the experiments is still very great; but within those limits of accuracy which have been as yet attainable, the experiments show that the heat generated in the

animal body corresponds to the amount which would be generated by the chemical processes. The animal body therefore does not differ from the steam-engine, as regards the manner in which it obtains heat and force, but does differ from it in the manner in which the force gained is to be made use of. The body is, besides, more limited than the machine in the choice of its fuel; the latter could be heated with sugar, with starch-flour, and butter, just as well as with coal or wood; the animal body must dissolve its materials artificially, and distribute them through its system; it must, further perpetually renew the used-up materials of its organs, and as it cannot itself create the matter necessary for this, the matter must come from without. Liebig was the first to point out these various uses of the consumed nutriment. As material for the perpetual renewal of the body, it seems that certain definite albuminous substances which appear in plants, and from the chief mass of the animal body, can alone be used. They form only a portion of the mass of nutriment taken daily; the remainder, sugar, starch, fat, are really only materials for warming, and are perhaps not to be superseded by coal, simply because the latter does not permit itself to be dissolved.

If, then, the processes in the animal body are not in this respect to be distinguished from inorganic processes, the question arises, whence comes the nutriment which constitutes the source of the body's force? The answer is, from the vegetable kingdom; for only the material of plants, or the flesh of plant-eating animals, can be made use of for food. The animals which live on plants occupy a mean position between carnivorous animals, in which we reckon man, and vegetables, which the former could not make use of immediately as nutriment. In hay and grass the same nutritive substances are present as in meal and flour, but in less quantity. As, however, the digestive organs of man are not in a condition to extract the small quantity of the useful from the great excess of the insoluble, we submit, in the first place, these substances to the powerful digestion of the ox, permit the nourishment to store itself in the animal's body, in order in the end to gain it for ourselves in a more agreeable and useful form. In answer to our question, therefore, we are referred to the vegetable world. Now when what plants take in and what they give out are made the subjects of investigation, we find that the principal part of the former consists in the products of combustion which are generated by the animal. They take the consumed carbon given off in respiration, as carbonic acid, from the air, the consumed hydrogen as water, the nitrogen in its simplest and closest combination as ammonia; and from these materials, with the assistance of small ingredients which they take from the soil, they generate anew the compound combustible substances, albumen, sugar, oil, on which the animal subsists. Here, therefore, is a circuit which appears to be a perpetual store of force. Plants prepare fuel and nutriment, animals consume these, burn them slowly in their lungs, and from the products of combustion the plants again derive their nutriment. The latter is an eternal source of chemical, the former of mechanical forces. Would not the combination of both organic kingdoms produce the perpetual motion? We must not conclude hastily: further inquiry shows, that plants are capable of producing combustible substances

only when they are under the influence of the sun. A portion of the sun's rays exhibits a remarkable relation to chemical forces,— it can produce and destroy chemical combinations; and these rays, which for the most part are blue or violet, are called therefore chemical rays. We make use of their action in the production of photographs. Here compounds of silver are decomposed at the place where the sun's rays strike them. The same rays overpower in the green leaves of plants the strong chemical affinity of the carbon of the carbonic acid for oxygen, give back the latter free to the atmosphere, and accumulate the other, in combination with other bodies, as woody fibre, starch, oil, or resin. These chemically active rays of the sun disappear completely as soon as they encounter the green portions of the plants, and hence it is that in daguerreotype images the green leaves of plants appear uniformly black. Inasmuch as the light coming from them does not contain the chemical rays, it is unable to act upon the silver compounds.

Hence a certain portion of force disappears from the sunlight, while combustible substances are generated and accumulated in plants; and we can assume it as very probable, that the former is the cause of the latter. I must indeed remark, that we are in possession of no experiments from which we might determine whether the *vis viva* of the sun's rays which have disappeared, corresponds to the chemical forces accumulated during the same time; and as long as these experiments are wanting, we cannot regard the stated relation as a certainty. If this view should prove correct, we derive from it the flattering result, that all fôrce, by means of which our bodies live and move, finds its source in the purest sunlight; and hence we are all, in point of nobility, not behind the race of the great monarch of China, who heretofore alone called himself Son of the Sun. But it must also be conceded, that our lower fellow-beings, the frog and leech, share the same ethereal origin, as also the whole vegetable world, and even the fuel which comes to us from the ages past, as well as the youngest offspring of the forest with which we heat our stoves and set our machines in motion.

You see, then, that the immense wealth of ever-changing meteorological, climatic, geological, and organic processes of our earth are almost wholly preserved in action by the light and heat-giving rays of the sun; and you see in this a remarkable axample, how Proteus-like the effects of a single cause, under altered external conditions, may exhibit itself in nature. Besides these, the earth experiences an action of another kind from its central luminary, as well as from its satellite the moon, which exhibits itself in the remarkable phenomenon of the ebb and flow of the tide.

Each of these bodies excites, by its attraction upon the waters of the sea, two gigantic waves, which flow in the same direction round the world, as the attracting bodies themselves apparently do. The two waves of the moon, on account of her greater nearness, are about three and a half times as large as those excited by the sun. One of these waves has its crest on the quarter of the earth's surface which is turned towards the moon, the other is at the opposite side. Both these quarters possess the flow of the

tide, while the regions which lie between have the ebb. Although in the open sea the height of the tide amounts to only about three feet, and only in certain narrow channels, where the moving water is squeezed together, rises to thirty feet, the might of the phenomena is nevertheless manifest from the calculation of Bessel, according to which a quarter of the earth covered by the sea possesses, during the flow of the tide, about 25,000 cubic miles of water more than during the ebb, and that therefore such a mass of water must, in six and a quarter hours, flow from one quarter of the earth to the other.

The phenomena of the ebb and flow, as already recognized by Mayer, combined with the law of the conservation of force, stands in remarkable connection with the question of the stability of our planetary system. The mechanical theory of the planetary motions discovered by Newton teaches, that if a solid body in absolute *vacuo*, attracted by the sun, move around him in the same manner as the planets, this motion will endure unchanged through all eternity.

Now we have actually not only one, but several such planets, which move around the sun, and by their mutual attraction create little changes and disturbances in each other's paths. Nevertheless Laplace, in his great work, the *Mécanique Céleste*, has proved that in our planetary system all these disturbances increase and diminish periodically, and can never exceed certain limits, so that by this cause the eternal existence of the planetary system is unendangered.

But I have already named two assumptions which must be made: first, that the celestial spaces must be absolutely empty; and secondly, that the sun and planets must be solid bodies. The first is at least the case as far as astronomical observations reach, for they have never been able to detect any retardation of the planets, such as would occur if they moved in a resisting medium. But on a body of less mass, the comet of Encke, changes are observed of such a nature: this comet describes ellipses round the sun which are becoming gradually smaller. If this kind of motion, which certainly corresponds to that through a resisting medium, be actually due to the existence of such a medium, a time will come when the comet will strike the sun; and a similar end threatens all the planets, although after a time, the length of which baffles our imagination to conceive of it. But even should the existence of a resisting medium appear doubtful to us, there is no doubt that the planets are not wholly composed of solid materials which are inseparably bound together. Signs of the existence of an atmosphere are observed on the Sun, on Venus, Mars, Jupiter, and Saturn. Signs of water and ice upon Mars; and our earth has undoubtedly a fluid portion on its surface, and perhaps a still greater portion of fluid within it. The motions of the tides, however, produce friction, all friction destroys *vis viva*, and the loss in this case can only affect the *vis viva* of the planetary system. We come thereby to the unavoidable conclusion, that every tide, although with infinite slowness, still with certainty, diminishes the store of mechanical force of the system; and as a consequence of this, the rotation of the planets in question round their axes must become more slow, they must therefore

approach the sun, or their satellites must approach them. What length of time must pass before the length of our day is diminished one second by the action of the tides cannot be calculated, until the height and time of the tide in all portions of the ocean are known. This alteration, however, takes place with extreme slowness, as is known by the consequences which Laplace has deduced from the observations of Hipparchus, according to which, during a period of 2000 years, the duration of the day has not been shortened by the one three hundredth part of a second. The final consequence would be, but after millions of years, if in the mean time the ocean did not become frozen, that one side of the earth would be constantly turned towards the sun, and enjoy a perpetual day, whereas the opposite side would be involved in eternal night. Such a position we observe in our moon with regard to the earth, and also in the case of the satellites as regards their planets; it is, perhaps, due to the action of the mighty ebb and flow to which these bodies, in the time of their fiery fluid condition, were subjected.

I would not have brought forward these conclusions, which again plunge us in the most distant future, if they were not unavoidable. Physico-mechanical laws are, as it were, the telescopes of our spiritual eye, which can penetrate into the deepest night of time, past and to come.

Another essential question as regards the future of our planetary system has reference to its future temperature and illumination. As the internal heat of the earth has but little influence on the temperature of the surface, the heat of the sun is the only thing which essentially affects the question. The quantity of heat falling from the sun during a given time upon a given portion of the earth's surface may be measured, and from this it can be calculated how much heat in a given time is sent out from the entire sun. Such measurements have been made by the French physicist Pouillet, and it has been found that the sun gives out a quantity of heat per hour equal to that which a layer of the densest coal ten feet thick would give out by its combustion; and hence in a year a quantity equal to the combustion of a layer of seventeen miles. If this heat were drawn uniformly from the entire mass of the sun, its temperature would only be diminished thereby one and one third of a degree centigrade per year, assuming its capacity for heat to be equal to that of water. These results can give us an idea of the magnitude of the emission, in relation to the surface and mass of the sun; but they cannot inform us whether the sun radiates heat as a glowing body, which since its formation has its heat accumulated within it, or whether a new generation of heat by chemical processes takes place at the sun's surface. At all events the law of the conservation of force teaches us that no process analogous to those known at the surface of the earth, can supply for eternity an inexhaustible amount of light and heat to the sun. But the same law also teaches that the store of force at present existing, as heat, or as what may become heat, is sufficient for an immeasurable time. With regard to the store of chemical force in the sun, we can form no conjecture, and the store of heat there existing can only be determined by very uncertain estimations. If, however, we adopt the very probable view, that the remarkably small density of so large a body is caused by its high tem-

perature, and may become greater in time, it may be calculated that if the diameter of the sun were diminished only the ten-thousandth part of its present length, by this act a sufficient quantity of heat would be generated to cover the total emission for 2100 years. Such a small change besides it would be difficult to detect even by the finest astronomical observations.

Indeed, from the commencement of the period during which we possess historic accounts, that is, for a period of about 4000 years, the temperature of the earth has not sensibly diminished. From these old ages we have certainly no thermometric observations, but we have information regarding the distribution of certain cultivated plants, the vine, the olive tree, which are very sensitive to changes of the mean annual temperature, and we find that these plants at the present moment have the same limits of distribution that they had in the times of Abraham and Homer; from which we may infer backwards the constancy of the climate.

In opposition to this it has been urged, that here in Prussia the German knights in former times cultivated the vine, cellared their own wine and drank it, which is no longer possible. From this the conclusion has been drawn, that the heat of our climate has diminished since the time referred to. Against this, however, Dove has cited the reports of ancient chroniclers, according to which, in some peculiarly hot years, the Prussian grape possessed somewhat less than its usual quantity of acid. The fact also speaks not so much for the climate of the country as for the throats of the German drinkers.

But even though the force store of our planetary system is so immensely great, that by the incessant emission which has occurred during the period of human history it has not been sensibly diminished, even though the length of the time which must flow by, before a sensible change in the state of our planetary system occurs, is totally incapable of measurement, still the inexorable laws of mechanics indicate that this store of force, which can only suffer loss and not gain, must be finally exhausted. Shall we terrify ourselves by this thought? Men are in the habit of measuring the greatness and the wisdom of the universe by the duration and the profit which it promises to their own race; but the past history of the earth already shows what an insignificant moment the duration of the existence of our race upon it constitutes. A Nineveh vessel, a Roman sword awakes in us the conception of gray antiquity. What the museums of Europe show us of the remains of Egypt and Assyria we gaze upon with silent astonishment, and despair of being able to carry our thoughts back to a period so remote. Still must the human race have existed for ages, and multiplied itself before the pyramids of Nineveh could have been erected. We estimate the duration of human history at 6000 years; but immeasurable as this time may appear to us, what is it in comparison with the time during which the earth carried successive series of rank plants and mighty animals, and no men; during which in our neighborhood the amber-tree bloomed, and dropped its costly gum on the earth and in the sea; when in Siberia, Europe and North America groves of tropical palms flourished; where gigantic lizards, and

after them elephants, whose mighty remains we still find buried in the earth, found a home? Different geologists, proceeding from different premises, have sought to estimate the duration of the above creative period, and vary from a million to nine million years. And the time during which the earth generated organic beings is again small when we compare it with the ages during which the world was a ball of fused rocks. For the duration of its cooling from 2,000° to 200° centigrade, the experiments of Bishop upon basalt show that about 350 millions of years would be necessary. And with regard to the time during which the first nebulous mass condensed into our planetary system, our most daring conjectures must cease. The history of man, therefore, is but a short ripple in the ocean of time. For a much longer series of years than that during which man has already occupied this world, the existence of the present state of inorganic nature favorable to the duration of man seems to be secured, so that for ourselves and for long generations after us, we have nothing to fear. But the same forces of air and water, and of the volcanic interior, which produced former geological revolutions, and buried one series of living forms after another, act still upon the earth's crust. They more probably will bring about the last day of the human race than those distant cosmical alterations of which we have spoken, and perhaps force us to make way for new and more complete living forms, as the lizards and the mammoth have given place to us and our fellow-creatures which now exist.

Thus the thread which was spun in darkness by those who sought a perpetual motion has conducted us to a universal law of nature, which radiates light into the distant nights of the beginning and of the end of the history of the universe. To our own race it permits a long but not an endless existence; it threatens it with a day of judgment, the dawn of which is still happily obscured. As each of us singly must endure the thought of his death, the race must endure the same. But above the forms of life gone by, the human race has higher moral problems before it, the bearer of which it is, and in the completion of which it fulfils its destiny.

IMPOSSIBLE PROBLEMS.

The following paper on "impossible problems," published during the past year by the well known mathematician, De Morgan, presents some points of novelty and scientific interest:

When we find a long and enduring discussion about any points of speculation, we naturally ask whether there be not some verbal difficulty at the bottom. What is the *solution of a problem?* It is the showing how to arrive at a desired result, under prescribed conditions to the means which are to be used, and as to the form in which the result is to be presented. There are then three possibilities of impossibility. The desired result may be among non-existing things; the prescribed conditions may be insufficient; the form demanded may be necessarily unattainable. And any one of these things being really the case, it may be impossible to *demonstrate* that it is the case. Human nature, which always assumes that it *can* know whatever can

be known, must bear to be told that this assumption may be one of its little mistakes, or may be a true exposition of its own powers, and may be a matter on which no certainty can be arrived at.

In prescribing conditions of solution, and form of result, we dictate to existence; we determine that our mental nature shall be so constructed that we shall know beforehand what means are wanted, and what form the result shall appear in, the matter being one on which the very necessity of proposing the problem shows our ignorance. And when we fail, we quarrel with the universe, as Porson did, when he proposed to himself the problem of taking up the candlestick, his condition being that in which two images of objects appear, one the consequences of the laws of light, the other what a psychologist would perhaps call purely subjective. He accordingly handled the wrong image, which of course did not prevent his fingers from meeting. Incensed at this, he exclaimed, "D—— the nature of things!" He had better have attended to preliminaries under which so simple a problem might have been solved without a quadratic equation.

Undoubtedly the dictation of conditions and of form has been attended with the most advantageous results. Abundance of possibles have been turned up in digging for impossibles. Alchemy invented chemistry; astrology greatly improved astronomy; the effort to find a certainty of winning in gambling nurtured the science under which insurance is safe and intelligible, and the inscrutable inquiry into *ens quatenus ens*, so properly placed *μετα τα φυσικα*, has added much to our powers of investigating *homo quatenus homo*.

There was a separate dictation of conditions in arithmetic and in geometry. In arithmetic, the simple definite number or fraction, the earliest object of our attention, was declared to be the universal mode of expression. It was prescribed to the circle that it should be, in circumference, a definitely expressible derivation from the diameter; it was demanded of the nature of things that by cutting the circumference into a certain number of equal parts, a certain number of those parts should give the diameter; and *vice versa*.

In geometry, Euclid laid down, as his prescribed instruments, the straight line and circle. Of all the infinite number of lines which exist, he would use none except the straight line and circle. It was demanded of the nature of things that it should be possible to construct a square equal to a given circle, without the use of any curve except the circle.

The second demand was not quite so impudent as the first. It was soon discovered and proved that there is no square root to 2, as a definite fraction of a unit. That is, there is nothing but an interminable series of decimals, 1.4142135 . . . . . .; by help of which we discover the square root of fractions within any degree of nearness to 2 we please. And yet, with such a result as this known to all, it was thought the most reasonable thing in the world to demand that the ratio of the circumference to the diameter should be that of number to number.

I will now speak of several problems of popular interest.

1. *The three bodies.* This is the problem of determining the motion of a planet attracted, not only by the sun, but by another planet. In the early days of the integral calculus, it was demanded of the nature of things that

all deferential equations should be soluble in what are called *finite terms,* that is by a definite number of algebraical, etc., terms consisting of our usual modes of expression. Mathematicians had not then opened their eyes to the fact that there exists an unlimited number of modes of expression of which those we employ cannot give an idea, except by interminable series. Accordingly, they considered the problem of three bodies unsolved so long as it was necessary to have recourse to these interminable series. But is this problem *unsolved,* in any other sense than this, that the nature of things has not listened to human dictation on matters which humanity knew nothing about? Do we not find the moon's place within a fraction of a second of time, by the existing solution? And did not Adams and Leverrier even solve the inverse problem, Given the effect produced upon a known planet by an unknown planet, to discover the place of the unknown planet? There are hundreds of problems, in pure and mixed mathematics both, which are treated only by interminable series, and which no one ever complained of as not being solved. The difference is this: we speak of these problems in the language of the newer day; we speak of the problem of the three bodies after the tradition of an older day.

It is not practicable, that is, it has not been found practicable, to *prove* the impossibility of solving the problem of three bodies without interminable series. But a long chain of cogent analogies convinces every one who has gone through them, with full moral evidence, that the finite terms must be *terms* of a kind of which we have at present no conception.

2. *The Perpetual motion.* — This is a problem of a very different kind. The purse of Fortunatus, which could always drop a penny out, though never a penny was put in, is a problem of the same kind. He who can construct this purse may construct a perpetual motion; in this way. Let him hang the purse upside down, and with the stream of pence which will flow out, let him buy a strong steam engine, and pay for keeping it at work day and night. Have a new steam-engine ready to be set in motion by the old one at its last gasp, and so on to all eternity. A perpetual motion demands of the nature of things a machine which shall always communicate momentum in the doing of some work, without ever being fed with any means-collecting momentum. It could be compassed, in a certain way, — that is, by retaining the work done to do more work, which again should be more, and so on, — if friction and other resistances could be abolished, and nothing thrown away. In this way the fall of a ton of water from a reservoir might be employed in pumping up as much water into another reservoir, which, when landed, if it be lawful to say so of water, might, by its subsequent fall, pump up an equal quantity into the original reservoir, and so on, backwards and forwards, *in secula seculorum.* But not a drop must be wasted, whether by adhesion to the reservoir, by evaporation, by splashing, or in any way whatever. Every drop that falls down must be made to raise another drop to the same height. So long as the sockets have friction, or the air resists, this is impossible. In fact, matter, with respect to momentum, has the known qualities of a basket with respect to eggs, butter, garden-stuff, etc. No more can come out than was put in; and every quantity taken out re-

quires as much more to be put in before the original state is restored. So soon as the law of matter is as clearly known as the law of the basket, there is an end of looking for the perpetual motion.

That people do try after a perpetual motion to this day is certain. A good many years ago a perpetual motion company was in contemplation; and the promoters did me the unsolicited honor of putting my name on the list of directors. Fortunately the intention came round to me before the list was circulated; and a word to the editor of a periodical produced an article which, I believe, destroyed the concern. The plan was to put a drum or broad wheel with one verticle half in mercury and the other in vacuum. This instrument, the most unlucky drum since Parolles, feeling the balance of its two halves very unsatisfactory, was to go round and round in search of an easy position, forever and ever, working away all the time, — I mean all the eternity, — at lace-making, or water-pumping, or any other useful employment. People were told that if they would sell their steam engines for old iron, they might buy new machines with the money, which would work as long as they held together without costing a farthing for fuel. Certainly, had the scheme been proposed to me, I should have declined to join until I had derived assurance from seeing the donkey who originated it turned into a head-over-heels perpetual motion by tying a heavy weight to his tail and an exhausted receiver to his nose.

3. *Quadrature of the circle.* — The *arithmetical* quadrature involves the determination of the circumference by a definite arithmetical multiplier, which shall be perfectly accurate. Lambert proved that the multiplier must be an interminable decimal fraction; and the proof may be found in Legendre's geometry, and in Brewster's translation of that work. The arithmeticians have given plenty of approximate multipliers. The last one, and the most accurate of all, was published a few years ago by Mr. W. Shanks, of Houghton-le-Spring, a calculator to whom multiplication is no vexation, etc. He published the requisite multiplier (which mathematicians denote by π) to six hundred and seven decimal places, of which 441 were verified by Dr. Rutherford. To give an idea of the power of this multiplier, we must try to master such a supposition as the following.

There are living things on our globe so small that, if due proportion were observed, the corpuscles of their blood would be no more than a millionth of an inch in diameter. Suppose another globe like ours, but so much larger that our great globe itself, is but fit to be a corpuscle in the blood of one of its animalcules; and call this the *first* globe aboveus. Let there be another globe so large that this first globe above us is but a corpuscle in the animalcule of that globe; and call this the second globe above us. Go on in this way till we come to the twentieth globe above us. Next, let the minute corpuscle on our globe be another globe like ours, with everything in proportion; and call this the first globe below us. Take a blood-corpuscle from the animalcule of that globe, and make it the second globe below us; and so on, down to the twentieth globe below us. Then if the inhabitants of the twentieth globe above us were to calculate the circumference of their globe from its diameter by the 607 decimals, their error of length could not

be made visible to the inhabitants of the twentieth globe below us, unless their microscopes were relatively very much more powerful than ours.

By the *geometrical* quadrature is meant the determination of a square equal to the circle, using only Euclid's allowance of means; that is, using only the straight line and circle as in Euclid's first three postulates. On this matter, James Gregory, in 1668, published an asserted demonstration of the impossibility of the geometrical quadrature. The matter is so difficult, and proofs of a negative so slippery, that mathematicians are rather shy of pronouncing positive opinions. Montucla, in the first edition of the work presently mentioned, only ventured to say that it was *very like* demonstration. In the second edition, after further reflection, he gave his opinion that the point was demonstrated. I read James Gregory's tract many years ago, and left off with an impression that probably more attentive consideration would compel me to agree with its author. But he would be a bold man who would be very positive on the point; even though there are trains of reasoning, different from Gregory's, which render it in the highest degree improbable, which are in fact all but demonstration themselves, that the geometrical quadrature is impossible.

To say that a given problem cannot be solved, because two thousand years of trial have not succeeded, is unsafe; far more powerful means may be invented. But when the question is to solve a problem *with certain given means and no others*, it is not so unsafe to affirm that the problem is insoluble. By hypothesis, we are to use no means except those which have been used for two thousand years; it becomes exceedingly probable that all which those means can do has been done, in a question which has been tried by hundreds of men of genius, patience and proved success in other things.

4. *Trisection of the Angle.* — The question is to cut any given angle into three equal parts, with no more assistance than is conceded in Euclid's first three postulates. It is well known that this problem depends upon representing geometrically the three roots of a cubic equation which has all its roots real: whoever can do either can do the other. Now the geometrical solution, as the word geometrical is understood, of a cubic equation, has never been attained; and all the *à priori* considerations which have so much force with those who are used to them are in favor of the solution being impossible. A person used to algebraic geometry cannot conceive how, by intersections of circles and straight lines, a problem should be solved which has three answers, and three only.

To sum up the whole. The problem of the three bodies has such solution as hundreds of other problems have; approximate in character, but wanting only pains and patience to carry the approximation to any desired extent. The problem of the perpetual motion is a physical absurdity. The arithmetical quadrature of the circle has been proved impossible in finite terms, but 607 decimal places of the interminable series have been found, and 441 of them verified. Of the geometrical quadrature an asserted proof of impossibility exists, which no one who has read it ventures to gainsay, but in favor of which no one speaks very positively. The trisection of the angle has no alleged proof of its impossibility. But were this the proper place, an

account might be given of those considerations which lead all who have thought much on the subject to feel sure that the difficulty arises from the restrictions placed upon the means of solution amounting to a little too much dictation to the nature of things. For it must be remembered that the problem is not to square the circle, nor to trisect the angle, but to square the circle or trisect the angle without recourse to any means except those afforded by Euclid's first three postulates. This limitation is frequently omitted; and persons are led to conclude that mathematicians have never shown how to square a circle, or to trisect an angle, than which nothing can be more untrue. I may take occasion to raise a query in some future communication, whether these difficulties would ever have existed if Euclid's ideas of solid geometry had been as well arranged as his ideas of plane geometry.

The reader may find details on this subject in the articles QUADRATURE and TRISECTION in the Penny Cyclopædia. But further information will be found in Montucla's *Histoire des Récherches sur la Quadrature du Cercle*, Paris, 1831, 8vo. (second edition). This work contains, besides the vagaries of the insufficiently informed, an account of the attempts of older days, which ended in useful discovery. In later times the whole subject has lapsed into burlesque; the few who have made rational attempts being lost in the crowd who have made absurd misconceptions of the problem. To square the circle has become a byword, though many do not know the problem under a change of terms, say the rectification of the circumference.

And so much for the impossible problems, which have caught so many ingenious minds, and almost always held them tight. For this reason, I should advise any one not to try them.

SCHONBEIN'S ELECTRICAL PAPER.

By a process similar to that used in the preparation of gun-cotton, Schönbein has succeeded in converting paper into a perfectly transparent substance, which, by the slightest friction, becomes extraordinarily electrified, and which he employed in the construction of an electrical machine.

Such a substance must be in the highest degree acceptable to the experimental physicist, and it is so much the more to be regretted that Schönbein and Böttger have published nothing further on this subject, although electrical paper is now offered for sale in Berlin. In most cases the electrical paper can be replaced by thin sheets of gutta percha.

SIMPLE ELECTRIC MACHINE.

M. Thore united the ends of a strip of paper about eight inches in width, so as to make a continuous band of it, and stretched it on two wooden pulleys covered with silk, one of which was rapidly turned around by a handle; the electricity was developed by pressing a warmed flat-iron upon the paper as it passed over one of the pulleys. He describes the effects as remarkable.

There is nothing new in the observation of the electricity developed by paper, and many of our machinists have noticed how often the bands of their

machinery became electrically charged. But the apparatus is simple and cheap, and capable of working under atmospheric conditions which arrest the action of our ordinary machines.

ELECTRIC CONDUCTING POWERS OF THE METALS OF THE ALKALIES AND ALKALINE EARTHS.

Dr. A. Matthiessen has made, under the direction of Prof. Kirchhoff, of Heidelberg, a series of experiments on this subject, the method of performing which is fully described in the London, Edinburgh and Dublin Philosophical Magazine, for February. The following are the results. The temperatures are in centigrade degrees.

The conducting power of silver at 0° being = 100.

That of	Sodium	at 21·°7	=	37·43
	Magnesium	17·	=	25·47
	Calcium	16·8	=	22·14
	Potassium	20·4	=	20·85
	Lithium	20·	=	19·00
	Strontium	20·	=	6·71

The potassium and sodium used, were commercial; the others were obtained electrotypically. Experiments were also made, and are reported in the original paper, on the variation of the conducting power by heat.

In these results an interesting fact was observable, namely, that at some distance from the point of fusion, as well in the liquid as in the solid state, the decrements in the conducting power with the increase of temperature were almost in proportion, but near the point of fusion the decrease in the conducting power became much more rapid; with sodium this change appears to be very sudden, whereas with potassium it seems gradual. This difference in these metals corresponds with their different behavior in fusion; namely, potassium does not become suddenly liquid like sodium, but first passes through a semi-fluid state.

SIMULTANEOUS AND OPPOSITE ELECTRIC CURRENTS IN THE SAME WIRE.

M. Petrina has investigated this disputed phenomenon by means of the reduction of temperature which Peltier discovered to take place when an electric current passes from bismuth to antimony. A metallic bar of these two metals soldered together in the middle, was introduced into the bulb of an air-thermometer, and divided currents from the same battery carefully equalized, were passed through it in opposite directions. In this case, if no current passes, no effect should be produced; but if both pass, since the cooling effects are known to be much less than the heat produced by the same current when passing in the opposite direction, the thermometer should indicate such heat. In fact, no effect was produced when the currents were equalized, and when they were allowed to be unequal, the heat was that due to the difference of the currents. — *Cosmos.*

ON SOME NEW METHODS OF PRODUCING AND FIXING ELECTRICAL FIGURES.

From certain experiments recently made by Mr. W. R. Grove, published in the Philosophical Magazine, the way appears to be opening for new applications of electricity, and for investigations rich in promise alike to science and art. It was known years ago to some of the German savans, that a coin or medal placed on a smooth vitreous or metallic surface and electrized, would leave impressions on that surface which became visible when breathed on. From the latter peculiarity they were called "roric figures;" and attempts were made to fix them by exposure to vapor of mercury or iodine, but without success. Where the Germans failed, Mr. Grove has succeeded: "Believing as I have for many years," he says, "that electricity is nothing else than motion or change in matter, a force and not a fluid, I have made experiments to ascertain whether similar effects take place in cases where electrical light is visible upon insulated surfaces only."

We give a brief sketch of the experiments, adopting Mr. Grove's description where it suits our purpose. Two plates of window-glass, about three inches square, were dipped in nitric acid, then washed, and dried with a clean silk handkerchief, and coated on the outside with pieces of tinfoil a little smaller than the glass. A piece of printed hand-bill was laid between the plates thus prepared; the tinfoil coatings were connected with the secondary terminals of Ruhmkorff's coil, and removed after a few minutes' electrization. Now, "the interior surface of the glass when breathed on, showed with great beauty the printed words, which had been opposite it, these appearing as though etched on the glass, or having a frosted appearance; even the fibres of the paper were beautifully brought out by the breath, but nothing beyond the margin of the tinfoil." These impressions were fixed by holding them over hydrofluoric acid, — powdered fluor spar and sulphuric acid slightly warmed in a leaden dish.

"I now cut out of thin white letter-paper," proceeds Mr. Grove, "the word Volta, and placed it between the plates of glass. They were submitted to electrization as before, and the interior surface of one of them, without the paper letters, was subsequently exposed in the hydrofluoric acid vapor; the previously invisible figures came out perfectly, and formed a permanent and perfectly accurate etching of the word Volta, as complete as if it had been done in the usual mode by an etching ground. This, of course, could be washed and rubbed to any extent without alteration; and the results obtained give every promise for those who may pursue this as an art, of producing very beautiful effects, enabling even fine engravings to be copied on glass, etc."

A plate on which the invisible image was impressed, was immersed in a bath of nitrate of silver, in the usual manner as for a photograph. "It was then held opposite a window for a few seconds, and taken back into the darkened room; and on pouring over it a solution of pyrogallic acid, the word Volta, and the border of the glass beyond the limits of the tinfoil, were darkened, and came out with perfect distinctness, the other parts of the glass

having been, as it were, protected by electrization from the action of light. The figures were permanently fixed by a strong solution of hyposulphate of soda."

ON A NEW METHOD OF OBSERVING ATMOSPHERIC ELECTRICITY.

At the British Association for 1856, Professor W. Thomson gave the following description of a method of observing atmospherical electricity, employed by Mr. Dellman, of Crenznach, Prussia, Mr. D. being employed by the government to make meteorological observations. It consists in using a copper ball about six inches diameter, to carry away an electrical effect from a position about two yards above the roof of his house, depending simply on the atmospheric "potential" at the point to which the centre of the ball is sent; and it is exactly the method of the "carrier ball" by which Faraday investigated the atmospheric potential in the neighborhood of a rubbed stick of shell-lac, and other electrified bodies ("Experimental Researches," series ix, 1839.) The whole process only differs from Faraday's in not employing the carrier ball directly, as the repeller in a coulomb-electrometer, but putting it into communication with the conductors of a separate electrometer of peculiar construction. The collecting part of the apparatus is so simple and easily managed that an amateur could, for a few shillings, set one up on his own house, if at all suitable as regards roof and windows; and, if provided with a suitable electrometer, could make observations in atmospheric electricity with as much ease as thermometric or barometric observations. The electrometer used by Mr. Dellman is of his own construction (described in Poggendorff's "Annalen," 1853, vol. 89, also vol. 85), and appears to be very satisfactory in its operation. It is, I believe, essentially more accurate and sensitive than Peltier's, and it has a great advantage in affording a very easy and exact method for reducing its indications to absolute measure. I wish also to suggest two other modes of observing atmospheric electricity which have occurred to me, as possessing each of them some advantages over any of the systems hitherto followed. In one of these I propose to have an uninsulated cylindrical iron funnel, about seven inches diameter, fixed to a height of two or three yards above the highest part of the building, and a light, movable continuation (like the telescope funnel of a steamer) of a yard and a half or two yards more, which can be let down or pushed up at pleasure. Insulated by supports at the top of the fixed part of the funnel, I would have a metal stem carrying a ball like Dellman's, standing to such a height that it can be covered by a hinged lid on the top of the movable joint of the funnel, when the latter is pushed up; and a fine wire fixed to the lower end of the insulated stem, and hanging down, in the axis of the funnel to the electrometer. When the apparatus is not in use, the movable joint would be kept at the highest, and its lid down, touching the ball so as to keep it uninsulated. To make an observation, the lid would be turned up rapidly, and the movable joint carrying it let down, an operation which could be effected in a few seconds by a suitable mechanism. The electrometer would immediately indicate an inductive electrification simply proportional to the atmospheric potential at

the position occupied by the centre of the ball, and would continue to indicate at each instant the actual atmospheric potential, however variable, as long as no sensible electrification or diselectrification has taken place through imperfect insulation or convection by particles of dust or currents of air (probably for a quarter or a half of an hour, when care is taken to keep the insulation in good order). This might be the best form of apparatus for making observations in the presence of thunder-clouds. But I think the best possible plan in most respects, if it turns out to be practicable, of which I can have little doubt, will be to use, instead of the ordinary fixed insulated conductor with a point, a fixed conductor of similar form, but hollow, and containing within itself an apparatus for making hydrogen, and blowing small soap-bubbles of that gas from a fine tube terminating as nearly as may be in a point, at a height of a few yards in the air. With this arrangement the insulation would only need to be good enough to make the loss of a charge by conduction very slow in comparison with convective loss by the bubbles, and it would be easy to secure against any sensible error from defective insulation. If one hundred or two hundred bubbles, each one-tenth of an inch in diameter, are blown from the top of the conductor per minute, the electrical potential in its interior will very rapidly follow variations of the atmospheric potential, and would be at any instant the same as the mean for the atmospheric during some period of a few minutes preceding. The action of a simple point is, (as I suppose, is generally admitted) essentially unsatisfactory, and as nearly as possible nugatory in its results. I am not aware how flame has been found to succeed, but I should think not well in the circumstances of atmospheric observations, in which it is essentially closed in a lantern; and I cannot see on any theoretical ground how its action in these circumstances can be *perfect*, like that of the soap-bubbles. I intend to make a trial of the practicability of blowing the bubbles; and if it proves satisfactory, there cannot be a doubt of the availability of the system for atmospheric observations.

ON THE EMPLOYMENT OF THE LIVING ELECTRIC FISHES AS MEDICAL SHOCK MACHINES.

Prof. George Wilson, in a paper before the British Association, Dublin, stated that his attention had been incidentally directed to the employment of the living torpedo as a remedial agent by the ancient Greek and Roman physicians; and he now felt satisfied that a living fish was alike the earliest and the most familiar electric instrument employed by mankind. In proof of the antiquity of the practice he adduced the testimony of Galen, Dioscorides, Scribonius, and Asclephiades, whose works proved that the shock of the torpedo had been used as a remedy in paralytic and neuralgic affections before the Christian era. A still higher antiquity had been conjecturally claimed for the electric silurus or malapterurus of the Nile, on the supposition that its Arabic name, Raad, signifies thunder-fish, and implied a very ancient recognition of the identity in nature of the shock-giving power and the lightning force; but the best Arabic scholars have pointed out that the

words for thunder (raad), and for the electric fish (ra'a'd), are different, and that the latter signifies the "causer of trembling," or "convulser," so that there are no grounds for computing to the ancient Egyptians, or even to the Arabs, the identification of silurus-power with the electric force. In proof of the generality of the practice of the zoo-electric machine at the present day, the writer referred to the remedial application of the torpedo by the Abyssinians, to that of the gymnotus by the South American Indians, and to that of the recently discovered electric fish (Malapterurus Beninensis) by the dwellers on the old Calabar River, which flows into the Bight of Benin. The native Calabar women were in the habit of keeping one or more of the fishes in a basin of water, and bathing their children in it daily, with a view to strengthen them by the shocks which they receive. These shocks are certainly powerful, for living specimens of the Calabar fish are at present in Edinburgh, and a single one gives a shock to the hand reaching to the elbow, or even to the shoulder. The usages referred to appear to have prevailed among the nations following them from time immemorial; so that they furnish proof of the antiquity as well as of the generality of the practice under notice. The writer concluded by directing the attention of naturalists to the probability of additional kinds of electric fish being discovered, and to the importance of ascertaining what the views of the natives familiar with them are in reference to the source of their power, and to their therapeutic employment.

Sir J. Richardson stated, that there were not less than eleven genera of fishes known that had the power of giving electric shocks. There was one peculiarity in all these fishes, and that was the absence of scales. In every one of them an apparatus had been discovered, which consisted of a series of galvanic cells, put in action by a powerful system of nerves. He read extracts from a letter from Dr. Baikie, now engaged in exploring the Niger, in which that gentleman stated that he had met with an electric fish in Fernando Po, and which Sir J. Richardson believed was identical with the Malapterurus, which had been described by Dr. Wilson, from the coast of Old Calabar. The natives called this fish the Tremble-fish.

ON A NEW SOURCE OF ELECTRICAL EXCITATION.

The following paper, by Mrs. Elisha Foot, was presented to the American Association for the Advancement of Science, at its last meeting: —

I have ascertained that the compression or the expansion of atmospheric air produces an electrical excitation. So far as I am aware this has not been before observed, and it seems to me to have an important bearing in the explanation of several atmospheric and electrical phenomena.

The apparatus used was an ordinary air pump of rather feeble power and adapted either to compress or exhaust the air. Its receiver was a glass tube about twenty-two inches in height and three in diameter, with its ends closed by brass caps cemented to it. At the bottom was a stop-cock and a screw by which it was attached to the air pump. To the top were soldered two copper wires, one hanging down within the tube, terminating in one or

more points, and extending to within about six inches of the bottom, the other extending from the upper side of the cap to an ordinary electrical condenser.

In experimenting after compressing or exhausting the air within the receiver, the wire reaching to the condenser was disconnected from it. The upper plate was lifted from its place by its glass handle, and its electrical condition tested by a gold leaf electrometer. I have found it convenient first to compress the air and close the stop-cock, when the condenser would be found to be charged with positive electricity. Then after discharging all traces of it both from the condenser and the wire leading to it, the air was allowed to escape, and the condenser would become recharged to an equal extent.

My experiments with this apparatus have extended over about eight months, and I have found the action to bear a strong analogy to that of the electrical machine. In damp or warm weather little or no effect would be produced, whilst at other times, particularly in clear cold weather, the action would be so strong as to diverge the leaves of the electrometer to their utmost extent. In warm weather, when no action would be produced, I have attained the result by cooling the air artificially. A sudden expansion or contraction always increases the effect.

The results with oxygen gas were similar, but I was not successful with either hydrogen or carbonic acid gases.

It is believed that the results which have been obtained on a small scale in my experiments may be traced in the great operations of nature. The fluctuations of our atmosphere produce compressions and expansions sufficient to cause great electrical disturbances. Particularly should this be observed in the dry cold regions of our atmosphere above the effects of moisture and vapors; and it was established by the experiments of Becquerel as well as those of Gay Lussac and Biot that the electricity of the atmosphere increases in strength with the altitude.

A manifest relation, moreover, between the electricity of the atmosphere and the oscillations of the barometer has frequently been observed. Humboldt, treating upon the subject in his Cosmos, remarks among other things that the electricity of the atmosphere, whether considered in the lower or the upper strata of the clouds in its silent problematical diurnal course, or in the explosion of the lightning and thunder of the tempest, appears to stand in a manifold relation to the pressure of the atmosphere and its disturbances.

The tidal movements of our atmosphere produce regular systematic compressions twice in twenty-four hours. These occur with so much regularity within the tropics, as observed by Humboldt, that the time of day is indicated within fifteen or twenty minutes by the state of the barometer. And Saussure observed a diurnal change in the electricity of the atmosphere corresponding with the diurnal changes of the barometer. The electricity of the atmosphere, he observes, has therefore a daily period like the sea, increasing and decreasing twice in twenty-four hours. It, generally speaking, reaches its maximum intensity a few hours after sunrise and sunset, and descends again to its minimum before the rising and setting of that luminary.

NEW LIGHTNING CONDUCTOR.

At a recent meeting of the Franklin Institute, Mr. J. D. Rice presented a new design for Lightning Conductors. The conductor is formed of fluted tubes of copper, joined by screw sockets, the ends of the tubes abutting, so that the communication is complete. The top is terminated, as in the most approved plans, with a single upright platina point, surrounded by radiating pointed copper wires, set at an angle with a vertical line. The object of the corrugations is, to present a greater surface in a less diameter, and to stiffen the material; they also give the conductor an ornamental appearance, which the generality of them do not possess.

THEORY OF THE VOLTAIC PILE.

During the thirty years in which the theory of the pile has been under discussion, research has favored apparently at one time the *chemical*, and at another the *contact* theory. We are able now, as we believe, to announce that the discussion is closed. The chemical theory has definitely triumphed. As explained in the Traite d'Electricité Théorique et Pratique of De la Rive, this theory meets all difficulties and proves that if contact is often necessary for exciting electricity, it is not that which produces it; chemical actions are always the source. This learned physicist demonstrates that all chemical action causes a disengagement of electricity, whilst not a single experiment can be cited in which electricity is produced simply by contact.

He reviews and explains all the alleged facts in favor of the theory of contact. He thus shows up the objection so often urged, that in order to displace by iron the copper of the sulphate of copper it is necessary to put the iron in contact with the saline solution, and that the chemical action begins only after the iron is covered with copper and when it has thus formed a voltaic couple. De la Rive first proves that in this experiment there is a voltaic couple which precedes that formed by the iron and by the displaced copper; this couple is formed by the iron and the oxide of iron adhering to its surface or by iron and carbon or some other foreign body; for by using iron chemically pure and a surface perfectly clean, no precipitation of copper is obtained.

No physicist is better fitted than De la Rive to undertake the delicate task of giving a theory of the pile. His studies as well as his discoveries lead him in this direction.

De la Rive was the first who recognized the important fact that zinc chemically pure is not attacked by hydrated sulphuric acid; that two metals on which pure nitric acid, for example, has no action, such as gold or platinum, give not the slightest trace of a current when put to the extremity of a galvanometer and plunged into the nitric acid; that on the contrary, they produce an instantaneous current when a drop of chlorohydric acid is added. The theory of contact has never yet explained this fact.—*Silliman's Journal.*

ON THE ELECTRIC CONDUCTIVITY OF COMMERCIAL COPPERS.

The following is an abstract of an important paper recently presented to the Royal Society G. B., "on the electric conductivity of commercial copper of various kinds." In measuring the resistances of wires manufactured for submarine telegraphs, the author was greatly surprised to find differences between different specimens, so great as most materially to affect their value in the electrical operations for which they are designed. It seemed at first that the process of twisting into wire rope, and covering with gutta percha to which some of the specimens had been subjected, may be looked to, to find the explanation of these differences. After, however, a careful examination of copper wire strands, some covered, some uncovered, some varnished with india-rubber, and some oxidized by ignition in a hot flame, it was ascertained that none of these circumstances produced any influence on the whole resistance; and it was found that the wire rope prepared for the Atlantic cable (No. 14, composed of seven No. 22 wires, and weighing altogether from 109 to 125 grains per foot) conducted about as well on the average as solid wire of the same mass, but in the larger collection of specimens which thus came to be tested still greater differences in conducting power were discovered than any previously observed. It appeared now certain that these differences were owing to different qualities of the copper wire itself, and it therefore became highly important to find how wire of the best quality could be procured. Accordingly four samples of simple No. 22 wire, and of strand spun from it, distinguished according to the manufactories from which they were supplied, were next tested, and the differences of conducting power were found to be 100, 96·05, and 54·9. Two other samples, chosen at random, about ten days later, out of large stocks of wire supplied from the same manufactories, were tested with different instruments, and exhibited as nearly as could be estimated the same relative qualities. It seems, therefore, that there is some degree of constancy in the quality of wire supplied from the same manufactory, while there is vast superiority in the produce of some manufactories over that of others. The great importance to shareholders in submarine telegraph companies, that only the best copper wire should be admitted for their use, is at once rendered apparent by the fact that a submarine telegraph constructed with copper wire having the conducting power of 100, and only one twenty-first of an inch in diameter, covered with gutta percha to a diameter of a quarter of an inch, would, with the same electrical power, and the same instruments, do more telegraphic work than one constructed with copper wire of one sixteenth of an inch diameter, having the conducting power of 54·9, covered with gutta percha to a diameter of a third of an inch. When the importance of the object is recognized, there can be little difficulty in finding how the best or nearly the best wire is to be uniformly obtained, seeing that all the specimens of two of the manufactories which have as yet been examined, have proved to be of the best, or little short of the best quality, while those of other manufactories have been found inferior in nearly constant proportions. The cause of these differences in electrical quality is a question not only of

much practical importance, but of high scientific interest. If chemical composition is to be looked to for the explanation, very slight deviations from perfect purity must be sufficient to produce great effects on the electric conductivity of copper, the following being the results of an assay made on one of the specimens of copper wire of low conducting power: —

Copper	99·75
Lead	·21
Iron	·03
Tin or Antimony	·01
	100·00

The entire stock of wire from which the samples experimented on were taken, has been supplied by the different manufactories as remarkably pure; and being found satisfactory in mechanical qualities, had never been suspected to present any want of uniformity as to value for telegraphic purposes, until Professor Thomson discovered the difference in conductivity referred to in his paper. Experiments show that the greatest degree of brittleness produced by tension does not alter the conductivity of the metal by as much as one half per cent. Experiments also showed that no sensible effect was produced on the conductivity of copper by hammering it flat. The author has not yet been able to compare very carefully the resistances of single wires with those of strands spun from the same stock, but it is certain that any deficiency which the strand may present when accurately compared with solid wire, is nothing in comparison with the differences presented by different samples chosen at random from various stocks of solid wire and strand in the process of preparation for telegraphic purposes.

ON THE ELECTRO-DYNAMIC INDUCTION MACHINE.

At the Dublin meeting of the British Association, Professor Callan, of Maynooth College, presented the result of a long series of experiments on the electro-dynamic induction machine. The first of these results is a means of getting a shock directly from the armature of a magnet at the moment of its demagnetization, by using, not a solid piece of iron, but a coil of very fine insulated iron for the armature of an electro-magnet, between the poles of which the coil would fit. When the helix of the magnet is connected with a battery, the armature is magnetized on account of its proximity to the magnetized iron; and when the battery connection is broken, if the ends of the insulated iron wire be held in the hands, a shock will be felt. The second result is the discovery of the fact, that if iron wires be put into a coil of covered copper wire, the ends of which are connected with a battery, and if another coil be connected with the same battery, the quantity of electricity which will flow through the latter will be greater when the first coil is filled with iron wires than when they are removed. The third result is, a core for the primary coil, which consists of a coil of insulated iron wire, and which has five advantages over all the cores in common use. First, there is no complete circuit for any electrical current excited in any section of the core, because all the spirals of the coil are insulated from each other, and no spiral returns to itself. In the common cores, even when the wires are covered

with thread, there is a complete circuit for every current induced in each section of every wire. Secondly, the currents in the various sections of the iron do not oppose each other; but the currents in each section of every wire are opposed by the currents flowing in the surrounding wires. Thirdly, in the iron coil all the currents in the various spirals flow in the same direction, and form one strong current, which may be used by connecting the ends of the coil with any body to which we wish to apply its force. But in the common cores all the currents in the sections of each wire remain within the wires, and cannot be used. Fourthly, the effect of the condenser on the currents produced in the iron core can be ascertained when an iron coil is used, but not with the common cores. By using an iron coil as a core, it is found that the condenser increases the intensity of the currents induced in the core. Fifthly, the ends of the iron coil, used as a core, may be connected with the coatings of a Leyden jar, and then the sparks from the coil are diminished in length, but increased in brightness. By the use of cores consisting of coils of insulated iron wires, electrical currents of considerable quantity and intensity may be obtained. These currents of quantity and intensity may answer for working the Atlantic telegraph, and for producing the electric light. Besides the cores just described, and the common core, Professor Callan used three other kinds of cores, viz: a flat or elliptical bundle of wires; a core made by coiling uninsulated iron wire on an iron bar; and a core consisting partly of a bundle of iron wire, and partly of a coil of insulated iron wire. The fourth result of his experiments is a new mode of insulation, in which imperfect insulation is used when imperfect insulation is sufficient, and perfect insulation is employed where such insulation is required. The advantage of this mode of insulation is, that each spiral in the secondary coil is brought nearer to the other spirals, as well as to the primary coil and core, than it can be in the common method of insulation, without at all diminishing the efficiency of the insulation. A coil in which the secondary wire was iron, and insulated in the manner described, was shown to the meeting, which, with a single cell, six inches by four, gave sparks half an inch long without a condenser. The insulation of the large condensers made by Professor Callan, in which the acting metallic surface of each plate exceeded 600 square feet, gave way before the coil which he exhibited was made; and, therefore, he could not say what the length of the sparks would be with the aid of a condenser. But were a condenser of the proper size to have the effect of increasing the sparks in a thirty-fold ratio, as in M. Gassiot's great coil, the length of the sparks produced by Professor Callan's coil with a single cell should be fifteen inches. The outer diameter of the coil was about four inches, its length twenty inches, and the length of the secondary coil about 21,000 feet. The fifth result is, a contact-breaker in which the striking parts are copper, and which acts as well as if they were platina. The sixth result is a mere explanation of the condenser, which is confirmed by the effect of the condenser on the electrical currents produced in the core. The last result consists in the discovery of some new facts relating to the condenser, from some of which it follows, that the ordinary mode of making the condenser is defective; for condensers are generally made so that the

entire surface of each of the metallic plates must act. But the condenser for every coil should be constructed in such a way that a small, or a considerable part, or the whole of the surface of each plate may be applied to the coil. For a large condenser which would make the effect of a coil excited by a single cell less than it would be without a condenser, will increase the effect of the same coil when it is connected with a battery of ten or twelve cells.

ON A MODIFIED FORM OF RUHMKORFF'S INDUCTION APPARATUS.

Mr. E. S. Ritchie of Boston, communicates to Silliman's Journal the following description of a modified form of Ruhmkorff's induction apparatus of his own device. He says — The induction apparatus made by Ruhmkorff, is generally familiar. By it is obtained a spark of three-fourths of an inch through the atmosphere. Mr. Hearder has described in the London Philosophical Magazine, (November and December 1846,) certain improvements by which he has lengthened the spark to three inches. The great difficulty experienced by him was in obtaining sufficient insulation between one stratum of the wire and the next above or below it, the entire thickness of the helix — including wire and insulation — being only about half an inch, and a tension of electricity sufficient to throw a spark three inches existing between the outer and inner strata. Mr. Stöhrer has adopted the plan of dividing the coil into three divisions, thus lessening the difficulty; still, great danger exists of the spark passing which would ruin the helix. I have endeavored to obviate this by winding the coil the *entire thickness as it progresses.* I commenced with a glass tube or bobbin, laying the first course on a cone at as great an angle as the wire could be conveniently laid — say about fifty degrees. The diameter at the tube was about two and one half inches and the greatest diameter three and one half inches, the length of the cone being nearly half an inch. When the stratum was laid, and cemented by resin and bees-wax, a ring of thin vulcanized rubber was stretched over and cemented, the wire passed down to the glass cylinder, and this wire covered also by rubber; then another stratum was laid in the same manner; — that is, the coil is built up precisely as a *cop* is laid by a mule-spinner. The advantages are that the wire in each conical layer is very short, and only a slight tension can exist between them.

With a helix thus made, with less than 7,000 feet of wire, I obtained a spark of two and one quarter inches; and with one since constructed on the same principle, with 30,000 feet of wire, differing only so far as I found necessary to enable me to wind the helix by a machine which I constructed for the purpose, I have obtained sparks over six inches long. I have constructed the condenser with oiled silk, with very thin gutta percha, and with paper of different thicknesses; but find tissue paper varnished and used double, according to Mr. Bentley's plan, the best. The surfaces used in the instruments above described are respectively about thirty and seventy-five square feet. I have used all the interruptors alluded to by the writers above mentioned, but prefer one which I have made thus: The anvil is a wire or small rod of platinum secured in a plate by a binding-screw; over this a

rod of platinum is secured in the same manner to a spring which presses them together; another spring loaded acts like a hammer upon the end of the first spring, to separate the platinum rods. A ratchet wheel presses down this spring hammer, and allows it to recoil and strike the other spring. By this the interruption is more instantaneously made, and the distance to which the platinum rods are separated easily regulated. This point appears to be of importance. The spark is lessened if the platinum rods are separated farther than actually to break their contact. The usual primary helix of large wire and the interior bundle of iron wires are placed within the glass tube.

In my last instrument, I used a tube closed at the top, more effectually to cut off the passage of the current from one end to the other, through the primary helix or iron wires. I have used a Bunsen's battery of four to six cells; four give the spark of as great length, but a few more cells increase the volume. I have applied a battery of eighteen cells and also a plate battery of fifty-six pairs without endangering the coil. The instrument is undoubtedly capable of being greatly increased in size and power.

Since writing the above, Mr. Ritchie further states: I have constructed a helix in which the plane of the strata of wires is perpendicular to the tube, insulated as before. With one of the same length of wire as the largest one before mentioned, — throwing a spark, with six cells, six inches, — I have used a battery of eighteen cells, (Bunsen's); but by using a battery of three series of six cells (that is, an *intensity* of six, and quantity of three), a very voluminous spark was obtained; as the action soon became feeble, I took the secondary coil from the glass cylinder and found that the current had *passed through the glass* near each end of the coil, forming a circuit through the primary wire; two minute holes, of a hair's breadth, from one-tenth to one-eighth inch diameter, were drilled through, but the glass was *not fractured;* it also passed through several thicknesses of vulcanized rubber. The helix was uninjured, proving the insulation obtained by the mode of winding it. A more perfect insulation between the helices is readily made; and I now use a tube of gutta percha over the glass. With powerful batteries the condenser of varnished paper is not sufficient, as the current passes entirely through, and with such I use oiled silk. I have put several condensers in the same instrument, connecting each by turning a screw, so that either or all can be used. Varied and beautiful effects are produced, particularly in vacuo, by using different amounts of surface of condenser.

At an exhibition of this apparatus before the American Association at its last meeting, the various phenomena of electrical light, were developed with a splendor rarely if ever equalled. In a subsequent discussion, Professor Henry observed that the phenomena developed by this machine indicated that electricity is only a polarization of matter, all of which is capable of one of the two forms of polarization — one by friction and one by magnetism; and the polarization of ponderable matter draws a line between electricity and magnetism.

THE BATTERY OF THE PROPOSED ATLANTIC TELEGRAPH.

When the Atlantic cable is in position at the bottom of the sea, telegraphic signals will be transmitted through it by induced magneto-electric currents, on account of the superior velocity this kind of electricity possesses over the ordinary voltaic current. These currents will be called forth by a somewhat complicated agency, the primary element in which will be a voltaic combination of a very novel and ingenious kind, devised by Mr. Whitehouse.

This battery, consisting of ten capacious cells, is made upon the Smee principle, so far as the adoption of platinized silver and zinc for its plates is concerned; but it differs from every form of combination that has hitherto been in use, in having the plates of each cell so subdivided into subordinate portions, that any one of these may be taken away from the rest for the purpose of renewal or repair, without the action of the rest of the excited surface of the cell being suspended for a single moment.

So long as a fair amount of attention is given to the renewal of its zinc element piece-meal, it is indeed literally exhaustless and permanent. This very desirable quality is secured by a singularly simple and ingenious contrivance. The cell itself is formed of a quadrangular trough of gutta percha, wood-strengthened outside, in which dilute acid is contained, the proportion of acid to water being one part in fifteen or sixteen. There are grooves in the gutta percha, into which several metal plates slide in a vertical position. These plates are silver and zinc alternately, but they are not pairs of plates in an electrical sense. Each zinc plate rests firmly at the bottom on a long bar of zinc, which runs from end to end of the trough, and thus virtually unites the whole into one continuous extent of zinc, presenting not less than two thousand square inches of excitable surface to the exciting liquid. Each silver plate hangs in a similar way from a metallic bar, which runs from end to end of the trough above, the whole of the silver being thus virtually united into one continuous surface of equal extent to the face of the zinc. The zinc does not reach so high as the upper longitudinal bar, and the silver does not hang down so low as the inferior longitudinal bar. The battery is thus composed of a single pair of laminated plates, although to the eye it seems to be made up of several pairs of plates. Nature has set the example of arranging extended surface into reduplicating folds, when it is required that such surface shall be packed away in a narrow space at the same time that a large acting area is preserved, in the laminated antennæ of the cockchafer. The antennæ, indeed, are the types of the Whitehouse battery. If any one of these reduplicated segments of either kind of metal is removed, the remaining portion continues its action steadily, the effect merely being the same that would be produced if a fragment of an ordinary pair of plates were temporarily cut away. The silver laminæ are of considerable thickness, and securely "platinated" all over; that is, platinum is thrown down upon their surfaces in a compact metallic form, and not merely in the black pulverulent state; consequently, they are almost exempt from wear. Each zinc lamina is withdrawn so soon as its amalgamation is injuriously affected, or so soon as its own substance is mainly eaten away

by the action of the chemical menstruum in which it is immersed, and a freshly-amalgamated, or new zinc lamina, is inserted into its place. The capability of the piece-meal renewal of the consumptive element of the battery in this interpolatory and fragmentary way, is then the cause of its "*perpetual maintaining*" power.

It may be added that one of these perpetual maintenance batteries has now been constantly at work for months in a large electrotyping office in London, and has thoroughly established its reputation for unparalleled steadiness, convenience and power. The battery is also unquestionably one of the most economical that has ever been set to work, considering the amount of service it is able to perform. *It is calculated that the cost of maintaining the ten-celled battery in operation at the terminal stations on either side of the Atlantic, including all wear and tear, and consumption of material, will not exceed one shilling per hour.*

The flashes of light and crackling sparks produced on making and breaking contact with the poles of this grand battery, are very undesirable phenomena in one particular. They are accompanied by a considerable waste of the metal of the pole. Each spark is really a considerable fragment of the metal absorbed into itself by the electrical agent, so to speak, and flown away with by it. When one of the poles of the battery is drawn two or three times along the sharp angle of an iron instrument, like a pair of pliers, the opposite end of the pliers being in contact with the other pole, the sharp angle is shaved away in the midst of a shower of sparks, just as if some irresistible and adamantine-toothed file had been carried along the same course. As the signals of the telegraph will be constantly made by making and breaking contact with the poles of the battery, these sparks would prove very costly and troublesome, eating away the material of the contact-key, and what is of more importance, very soon deranging its integrity and perfection as a mechanical means of communication and transmission. The Electrician of the company has very nearly eliminated this difficulty by a contrivance of considerable ingenuity. First he arranged a set of twenty brass strings, something of the form and appearance of the keys of a musical instrument, in opposite pairs, so that a round horizontal bar, turning pivotways on its own centre, and flattened at the top, could lift by an edge either of the sets of ten springs, right or left, as it was turned. This enabled the contact to be distributed through the entire length of the edge, and breadth of the brass strings, and the course of the current to be reversed, accordingly as the right or left edge (the bar being worked by a crank handle) was raised to the right or left set of springs; the right set, it will be understood, being the representatives of one pole of the battery, and the left set of the other pole. By this arrangement four fifths of the spark were destroyed, simply on account of the large surface of metal, through which the electrical current had to pass when contact was completed. Still there remained enough to constitute a very undesirable residue. This was disposed of finally, after sundry tentative attempts, by coiling a piece of fine platinum wire, and placing it in a porcelain vessel of water, and then leaving this fine platinum coil in constant communication with the opposite poles. As much electricity as

this little channel can accommodate, is constantly running through it from pole to pole, making it very hot, but it is kept from getting red-hot by the water in which it is immersed. The water is sustained at a boiling temperature to the relief of the fine filament of heated metal. When contact is made or broken by the key, this subsidiary contrivance being in operation, the main body of the current passes through the key, and the slight leaking still goes on through the platinum wire, but no spark appears. The contact is entirely lightless and quiet. The spark is absorbed in the maintenance of the leak. There is a slight increased consumption of zinc in the battery on account of this leak. The battery is always in subdued operation, instead of being in absolute rest between the successive contacts made for the transmission of the currents.

This battery, it is to be understood, is not to be used primarily in operating the telegraph, but for exerting a magneto-electric current, which will be subsequently used for signalizing.

IMPROVEMENTS IN GALVANIC BATTERIES.

Kuhns's Battery. — Kuhns of Bavaria, has found by experiment, that in a battery the ratio of the zinc surface to that of copper depends, in a great measure, on the quality of both substances, and that to produce economically the greatest result, the relative sizes have to be found experimentally in each case. For this reason he uses amalgamated wires of zinc, instead of the usual cylinders, and increases progressively the quantity of it till the maximum strength of current is reached. The same inventor has also discovered that, when the battery is heated to 120° Fahrenheit, the current produced is stronger than at any other temperature, and he has invented a battery which may be heated easily. It consists of a cast-iron box divided into two portions by a false bottom. The elements are placed side by side in the upper compartment in a bed of sand. In the lower compartment is an alcohol lamp. The sand gets uniformly heated, and keeps the elements at the proper temperature. After a little practice any person will find how the wick of the lamp has to be trimmed to heat the sand up to 120°, and keep it at that temperature. This process is used in most Parisian coffee-houses to keep coffee as warm as possible without spoiling it by boiling. It is probable that the strength of current is proportional to the quantity of chemicals used up, whatever be the process for producing the same. Hence the question, Will warming the battery increase the strength of the current, more economically in cost of apparatus, expense of chemicals, labor and risk of getting out of order, than making it larger by adding more of the elements?

Doat's New Battery, with a constant Current. — In this battery the zinc is replaced by mercury, the acidulated water by iodide of potassium; the nitric acid, or sulphate of copper of the batteries with two liquids, by iodine dissolved in the iodide of potassium, and, which put in excess in the solid state, serves to maintain constant action. Carbon is employed as the negative pole. A square trough, of gutta percha, contains the mercury and the alkaline iodide. The carbon and the iodized iodide are put into a square

porous cup, which is immersed in the liquid of the trough, two centimetres above the level of the mercury. The battery, once in action, requires no other care than that of drawing off with a glass syphon, the liquid saturated with iodide of mercury, which is to be restored to its primitive elements. The couple thus arranged and exhibited recently before the French Academy, possessed a feeble electro-motive force. It was but little stronger than a couple with sulphate of copper, and only one third that of a couple with nitric acid. Its force was such that, for a trough of about five decametres square, and with a thickness for the bed of iodide of potassium of about three centemetres, it was equivalent to ten metres and a half annealed copper wire, one millimetre in diameter, this wire being at 0° centigrade in temperature.

The process adopted by Mr. Doat for economizing the residues, admitting of some improvement, he made changes which have increased the power of his batteries.

The main point consists in substituting zinc amalgam for mercury; he obtains thence iodide of zinc, and the restoration of this compound to its elements, which at first appeared difficult, he has rendered easy by using a hydrated carbonate of copper. Whilst the soluble salts of oxide of copper in reacting on the alkaline iodides precipitate only one half, the basic salts, and especially the carbonate, exercise hardly a sensible action on the alkaline iodides, but act with the greatest rapidity on the alkalino-earthy or metallic iodides, and eliminate the whole of the iodine, the oxide passing to the state of a suboxide, and the metal combining with the iodine becoming oxidized. This action, which goes on rapidly at the ordinary temperature, is instantaneous at 50° C.

On the flat carbon pole, there is placed a broad filter of porous earth, containing hydrated carbonate of copper. When the battery has been for a while in action, the liquid, consisting of double iodide of zinc and potassium, is drawn from the troughs and thrown upon the filter, where it is decomposed by the copper salt. The alkaline iodide remains pure and the iodide of zinc is changed into an oxide of this metal, whilst the iodine set at liberty is dissolved in the alkaline iodide, and passes with it through the filter and falls upon the carbon pole. Thus the processes for recovering the iodine requires only the drawing off the liquid and putting it in a filter charged with hydrated carbonate of copper. The products left on the filter are oxide of zinc and carbonate of copper. They are mixed with charcoal and fused at a red heat. The result is a brass always in demand in commerce. The hydrated carbonate of copper is prepared by double decomposition by means of sulphate of copper and carbonate of soda. The latter is the only product which is lost; all the others, the iodine, iodide of potassium, mercury, zinc and copper, are re-obtained and may serve again in the battery, or be useful elsewhere.

Mr. Doat does not perform the reduction of the zinc and copper except when it can be done on a large scale; for he then obtains a casting of brass, of greater commercial value.

A Battery, called a Battery with triple contact. — One element of this bat-

tery consists of a glass or stone ware cup, at the bottom of which there is a plate of non-amalgamated zinc communicating without by means of a conducting strip. Above the plate of zinc there is a spiral formed of a rolled copper plate having an attachment for making connections. A solution of sulphate of potash covers entirely a plate of zinc, and wets to a certain height the plate of copper. Immediately on making the connections between the copper and zinc, an electric current is established which continues constant for several weeks.

The inventor of this battery is an Italian, Francesco Selmi, Professor of Chemistry in the University of Turin. The novel and important point of it is the triple contact, viz., between the sulphate of potash and zinc, the sulphate of potash and copper, and between the copper and the air. Professor Selmi has observed that there is a great advantage in this contact of the air with the copper immersed in the sulphate of potash, finding that the electric current is sensibly weakened when the copper is wet throughout.

Jedlik's Improved Battery. — At the last meeting of the German Association for the Promotion of Science, Professor Jedlik explained a modification of Professor Bunsen's battery, made by him, with the assistance of MM. de Csapo and Hammer. The septa of the cells in this modified battery are made of Professor Schönbein's paper, which may easily be repaired with collodion, and opposes little resistance to the passage of the galvanic current. The first experiments were made in 1844, with a one-celled, wood-framed Grove's battery. Afterwards Professor Jedlik succeeded in preparing a mixture of sulphur, cinnabar (or oxide of iron), and asbestos, of sufficient solidity, and which sufficiently resisted the action of nitric acid. A battery of one hundred elements, constructed on Professor Jedlik's plan, although much damaged by transport, was exhibited at Paris in the summer of 1855. When still unimpaired, forty of these elements gave, with charcoal tops at the ends of the polar wires, a light equal in intensity to the united flames of 3,500 common candles.

TELEGRAPHIC MEMORANDA.

At the meeting of German naturalists at Vienna, last September, M. Ginti showed that one telegraphic circuit will affect another which may happen to be near it, though the latter be altogether unconnected with the battery. Pass a current through the first, and the second, as demonstrated by the galvanometer, is visibly affected — in some as yet unexplained way through the earth.

Improvement in House's Telegraph. — An improvement, known as Baine's Printing Telegraph, has been effected on House's instrument. The main parts of House's machines are type-wheels, which are made to revolve alike at the different stations, so that when they are all stopped at the same instant by breaking the current, the same letter is, at every place, in front of the instrument. Sometimes one wheel gets in advance of the others, and remains so until put back by the operator. This getting out of register is obviated in the new improvement, by giving the type-wheels a vibrating mo-

tion. After telegraphing each letter, these wheels come back to the starting point, so that if the machine makes an error it is confined to one letter. In another part of the arrangement, denominated the mutator, which is in the main telegraphic circuit, there is such a combination with a permanent electro-magnet, that the greatest of all difficulties in stormy weather, that of adjusting the magnet, is removed, as the mutator is self-adjusting to a great extent, and a line of telegraph can be successfully operated by its use when all other magnets are unmanageable.

The inventor expects that these instruments, in addition to the ordinary employment, will be extensively used by newspaper offices, merchants and brokers, as they require no skill in handling, and cost but little.

Curious anticipation of the discovery of the magnetic telegraph. — The principle of the magnetic telegraph, devised by Wheatstone, was foreshadowed one hundred and twenty-eight years ago, in Bailey's Dictionary for 1730, — which contains the following: —

"Some authors write, that by the help of the magnet or loadstone persons may communicate their minds to a friend at a great distance; as suppose one to be at London, and the other at Paris, if each of them have a circular alphabet, like the dial-plate of a clock, and a needle touched with one magnet, then at the same time that the needle at London was moved, that at Paris would move in like manner, provided each party had secret notes for dividing words, and the observation was made at a set hour, either of the day or of the night; and when one party would inform the other of any matter, he is to move the needle to those letters that will form the words, that will declare what he would have the other know, and the other needle will move in the same manner. This may be done reciprocally."

Application of Steam to Telegraphic Purposes. — Mr. Boggs, a well known electrician of London, proposes to overcome the great obstacle to rapid telegraph communication, viz., the slowness of the recording process, by the following invention: — A series of gutta percha bands, about six inches wide, and a quarter of an inch thick, are coiled on wheels or drums arranged for the purpose. These bands are studded down both sides with a single row of holes at short intervals apart. When a message is to be sent, the clerks wind off these bands, inserting in the holes small brass pins, which according to their combination in twos and threes (with black holes between) represent certain words or letters. In this manner the message is, as it were, "set up" in the bands with great rapidity, and if the number of bands employed is sufficiently large — say as numerous as the compositors employed in a large printing office — messages equal in length to five or six columns of a newspaper could be set up and ready for transmission in the course of a single hour. Of course this operation in no respect interferes with the telegraph wire itself, which continues free for use until the bands of messages are actually being despatched. The gutta percha bands, when full, are removed to the instrument room, by a simple appliance, preventing any derangement or falling out of the pins while being moved about. In the instrument room the bands are connected with ordinary steam machinery, by which they are drawn in regular order with the utmost rapidity between

the charged poles of an electrical machine in such a manner that, during the moment of each pin's passing, it forms electrical communication between the instrument and the telegraph, and a signal is transmitted to the other end of the wire, where the spark perforates a paper and records the message.

In consequence of a terrible gale during the latter part of the year 1856, the two sub-marine cables between the French coast at Calais and Ostende and the English coast at Dover were broken by a vessel dragging its anchor over them. For some time after this, England had no communication with the continent except by the way of Holland. The Calais connection has now been reëstablished. The engineer charged with this work made use of the opportunity to examine the cable at the place of rupture, and he states that the conducting wires were perfectly uninjured in their envelop of gutta percha, notwithstanding the five years' immersion in sea water.

THE SUBMARINE ATLANTIC TELEGRAPH.

The first attempt to carry out the project of extending a submarine telegraph cable across the Atlantic, between the western coast of Ireland and St. John's, Newfoundland, was unsuccessfully made in the month of August, of the past year. Without entering into a detailed account of all the particulars of this important undertaking, it is sufficient, as a matter of record in these pages to say, that after the successful deposition of 335 miles of cable, the line broke, and the enterprise was for the present arrested. The maximum depth attained to was upwards of 2000 fathoms, and the electrical working of the cable up to the time of the accident, was in every respect satisfactory. The general result of the undertaking has conclusively demonstrated that there are no insuperable obstacles to be encountered, and that under more favorable circumstances the project will be successfully carried out.

The Directors of the Company, in a Report issued subsequent to an investigation of the accident, say:—" Sufficient information has already been obtained to show clearly that the present check to the progress of the work, however mortifying, has been purely the result of an accident, and is in no way due to any obstacle in the form of the cable, nor of any natural difficulty, nor of any experience that will in the future affect in the slightest degree the entire success of the enterprise. The only sudden declivity of any serious magnitude (from 410 fathoms to 1,700 fathoms) had been safely overcome, the beautiful flexibility of the cable having rendered it capable of adapting itself, without strain, to circumstances which would probably have been its ruin had it been more rigidly constructed. The combined influence of the temperature of the water, and the compression of the pores of the insulating medium, had practically shown that the action of a telegraphic cable, so far from being impaired, is materially improved by being sunk in deep water. These and all other circumstances which have been brought out by the recent expedition have made more and more cheering and certain the prospects of complete success on the next occasion."

Since the commencement of the undertaking the electricians of the com-

pany, Messrs. Whitehouse and Bright, have devoted much time to a series of carefully conducted experiments, with a view of determining the influence of induction, and disguised electricity in retarding the transmission of currents along submarine wires. An account of these experiments has been officially published by the company, from which we make the following extracts: —

In the ordinary arrangement of the wires of the electric telegraph, where they are stretched upon posts and insulated by glass and the surrounding air, the current of electricity runs along as a simple stream, and with a velocity that is almost inappreciable for ordinary distances. But when the wires are inclosed in a sheath of insulating substance, like gutta percha, and placed in a moist medium or a metallic envelop, the case is very different. The influence of induction then comes into play as a retarding power. As soon as the insulated central wire is electrically excited, that excitement operates upon the adjoining layer of metal or moisture, and calls up in it an electrical force of an opposite kind. Each of these forces disguises, or holds fast, an equivalent portion of the other, — and the electricity of the central wire is thus prevented from moving freely onward as it otherwise would. It is found, in short, that the submarine telegraph cable is virtually a *lengthened out Leyden jar*, and transmits signals *while being charged and discharged*, instead of merely by allowing a stream of the electrical influence to flow dynamically and evenly along it. And every time it is used it has first to be filled and then emptied. In the case of a long submarine wire this was found to be a task requiring considerable time, — and this was found, moreover, to be very much increased with an increase in the length of the wire.

In the early experiments made for the determination of the speed with which the subtle influence travelled along metallic wires, hundreds of thousands of miles appeared to be traversed in a second of time. But when a similar examination was entered upon with telegraphic lines running between London, Manchester and Glasgow, and laid under ground, and between London and Paris, and London and Brussels, partly under ground and partly submarine, it seemed that scarcely thousands of miles were passed in the same period; indeed, the statement was made in a paper read by Mr. Edward Bright, at the meeting of the British Association in 1854, *that the velocity of currents in ordinary use for telegraphic purposes in subterranean conductors did not exceed one thousand miles per second.* This gentleman also inferred from experiments carried on in a circuit of 480 miles of underground wire, that the speed with which an electrical impulse was transmitted varied with the energy or intensity of the current employed, and the nature and conditions of the conductor used, and hence that the rate of transmission might be greatly increased at will by adopting currents of a different character to those which had been habitually trusted to.

Professor Faraday had at once attributed these experimental discrepancies to their true cause; and Mr. Whitehouse exhibits a very beautiful and convincing experimental proof that it is as Leyden jars, and by retention of charge, that submarine cables act. He takes, first, fifteen miles of insu-

lated wire, with a conducting layer external to its insulating investment, and turns up its further end into the air, and he then does the same thing with a two hundred miles length of the same wire. He next communicates as full a charge to each of these lengths as they have the capacity to retain. Then he discharges each, allowing the discharge to flow through a fine wire coiled round a bar of soft iron, so that the bar may be rendered a magnet *pro tempore* during the actual current of the electricity. Upon measuring the force of each discharge-current, estimating it by the number of grains the temporary magnet is able to lift, he finds that where the fifteen mile length of the wire is concerned, the weight lifted amounts to 1,075 grains, and that where the two hundred mile length is concerned, the weight lifted amounts to 2,300 grains. A current which lifted 18,000 grains by simply running through the apparatus thus arranged, upon being sent into a coated insulated wire 498 miles long, lifted 60,000 grains when allowed to flow back as discharge, and even 96,000 grains if the discharge passed from both ends of the wire at once, and round the same temporary magnet. The significance of this result, reduced to plain terms, is simply this — *the wires act as reservoirs, and not as mere channels, and accordingly the larger reservoir receives and holds a larger quantity of the influence than the smaller one, and this larger quantity naturally produces the most powerful effects when it is allowed to escape from its imprisonment.* If the wires were acting as common conductors, the longer wire would produce the weaker effect on account of the electrical influence being attenuated through its extent. As they are operating as Leyden jars, or reservoirs, the longer wire is the most capacious receptacle, and produces the most energetic result, as its contents are poured out. It is now a familiar fact, that sensitive magnetic needles, placed by the side of a long and completely insulated wire when it is charged, give clear indication of the first "rush" of the influence into the wire, of the retention of the charge for several minutes after the charging contact has been broken, and of the final "rush out," or discharge of the influence in the opposite direction, when the wire is connected with the earth by its nearer end.

When the fact had been satisfactorily made out that the insulated marine wire must act as a Leyden jar, and be affected by charge and discharge, it became a matter of the highest practical importance to determine whether there was any peculiarity in this mode of operation which might be expected to interfere with the final success of telegraphy, in its application to long distances of sea circuit. A length of 166 miles of cable chancing to be in process of manufacture at Greenwich, the opportunity was seized to carry practical research into the matter. This cable contained three very perfectly insulated wires, arranged side by side in its core of gutta percha, in such a manner that they could very easily be connected together by their ends, so as to make an available length of wire for experiment of 498 miles.

The first thing done with this arrangement was the experimenter's satisfying himself that he might use the results of his experiments as fair expressions of what would take place in an extended wire 498 miles long, notwithstanding the three several wires, which formed successive parts of the line, lying side by side in the narrow dimensions of the gutta percha core.

A careful examination was made of the influence each wire exerted upon its neighbor, in setting up slight charges of an opposite kind of electricity inductively, and it was found that *the inductive influence thus exerted was only a ten-thousandth part of that which was transmitted along either of the wires, 166 miles long.* The results were attained by passing currents in various directions and in various ways along three wires simultaneously, and by estimating the differences of power in each, by their diverse capabilities of magnetizing soft iron bars.

By 1855 the scientific *corps* had provided themselves with much more complete and perfect instruments for pursuing these inquiries; and the construction of new telegraph lines had also furnished them with better opportunities of making their experiments. It was soon found that a magneto-electrical current took a second and a half to discharge itself, when it moved through 1,146 miles of wire, in consequence of the retarding power of induction in this extended medium. This was a rate of speed not at all compatible with any profitable employment of a trans-atlantic telegraph for commercial purposes, — and the next step was to devise some remedy for this inductive obstacle. The first thing done was to send different kinds of electricity along the wire in succession, in the hope that each transmission of one kind would clear away the residue of the other which had immediately preceded it. The result was a complete success. Although the same wire and the same magneto-electric combination were employed which had before demanded a second and a half for the completion of a single discharge, seven and eight currents now readily recorded themselves in a single second. When positive followed negative, and negative followed positive, in exactly equal proportions, the electrical equilibrium of the wire was continually restored as fast as it was disturbed, — each current clearing away the inductive influence which the other had left behind it. It was proved, moreover, in the course of these experiments, that successive charges of electrical influence, — either of the same kind or of alternate opposite kinds, — may be travelling along lengthened conducting wires simultaneously, — the one following the other like successive waves upon the sea. Alternate positive and negative signals were sent along 900 miles of wire, at the rate of eight signals in each second, — and two signals arrived at the end of the wire after the acts of transmission had been discontinued. In another experiment by the use of a wire 1,020 miles long, three signals of a single-stroke bell were distinctly heard after the movement of the hand which originated the current had ceased. This, therefore, indicated a way in which the rapidity of transmitting electrical currents along a submarine wire could be increased; it was necessary only to employ *opposite kinds,* — positive and negative alternately.

The next point to be investigated was the ratio in which increase of distance in a gutta percha covered telegraph wire augments the difficulties of rapid transmission. It had been supposed that the available force was diminished in the ratio of the square of the distance traversed, — that is, that a current which has traversed 600 miles has only a *thirty-sixth* part of the working force of a precisely similar current which has travelled only 100

miles. In experimenting upon this point they had to consider: First, the diminution of the current's power to produce mechanical effects; and, Second, its *loss of speed.* A voltaic battery of seventy-two pairs of plates, each with a surface of sixteen inches, was set to work, and it was ascertained how many grains the current would raise in an instrument contrived for this purpose, and called the Magneto-Electrometer, upon being transmitted through a wire just long enough to effect the connection. The number of grains lifted was 25,000. The experiment being repeated with the same current through 200 miles of wire, the number of grains lifted was 10,650; with 400 miles of wire it was 3,250; and with 600 miles it was 1,400. Clearly the loss of mechanical power in this case was not diminished in so large a ratio as had been supposed. In regard to loss of speed, nearly five thousand observations were made, with wires varying in length from eighty-three to one thousand and twenty miles, to determine its ratio; and from these it appeared that with a wire eighty-three miles long the transmission was effected in .08 of a second; with 166 miles in .14 of a second; with 249 miles in .36 of a second; with 498 miles in .79 of a second; and with 1,020 miles in 1.42 of a second. Taking eighty-three miles as the unit, there was in these observations a series of distances employed, which would be represented by numbers 1, 2, 3, 6 and 12. Consequently, if the law of the squares of distance had applied, the transmission through the thousand mile length of wire should have been one hundred and forty-four times as slow as through the eighty-three miles length, or in other words, it should have required nearly twelve seconds for its completion. The result of a very large number of direct experiments and observations, pretty well established the fact, that the velocity of movement of a magneto-electric current, through a gutta percha covered copper wire of the size of sixteen gauge, is 300 miles in from one-twelfth to one-sixteenth of a second; 600 miles in from one-sixth to one-ninth of a second; and 900 miles in from one-fifth to one-fourth of a second. The series of distances being represented by 1, 2, 3 — the corresponding series representing velocity becomes one-quarter, one-ninth, one-sixteenth, or thereabouts. With a wire 500 miles long, 350 distinct signals were attainable in a period which allowed of exactly 270 distinct signals, when a wire 1,020 miles long was used.

But the extent of the conductor is obviously not the only element concerned in the velocity of transmission, for wires of equal dimensions and of like composition. The velocity varies with the strength or quantity of the electrical current sent through any given wire. Seven small pieces of zinc were prepared and covered entirely with sealing wax, fragments of copper wire being attached to serve as copper plates. The sealing wax was then chipped off just from the point of each, leaving a portion of the metal bare, to the extent of scarcely the size of the letter o on this page. These zinc plates having been put into seven small acid-charged cells, and so constituted a voltaic battery, a receiving instrument was set printing by means of their Lilliputian energies through 600 miles of wire. The printing instrument performed its work with the utmost facility, but, by means of the recording apparatus already described, it was proved that the current took nine-tenths

of a second to make its journey. From a voltaic sand-battery of twelve pairs of four-inch plates, the current took forty-four hundredths of a second to traverse 600 miles of wire.

Yet again; currents of a different quality travelled with different degrees of velocity, even when equal to mechanical tasks of like amount at the extremity of any given wire. Seventy-two pairs of sand-battery plates, (each sixteen square inches in area), which lifted 1,400 grains in the magneto-electrometer at the end of a 600 miles wire, generated a current which took forty-four hundredths of a second to traverse that distance. Two large double induction coils, thirty-six inches long, (the secondary coils being composed of a mile and a third of fine wire), and excited by ten pairs of plates of 100 square inches each, arranged as a Smee's battery, gave rise to a current which could only lift 745 grains at the end of a 600 miles wire, but the current in this case travelled through the entire stretch of wire in nineteen-hundredths of a second. Simple voltaic electricity was capable of a greater mechanical effort at the end of a long wire, than a magneto-electric current; but the voltaic electricity, which was capable of the greater mechanical effort, strange to say, *travelled through the insulated wire at a considerably lower rate of speed.* A very large number of experiments combined to prove that a rate of transmission could be obtained by the employment of magneto-electric currents from two and a half to three times as great as that of any voltaic impulse that could be used. The mean or average speed for voltaic electricity in a number sixteen gauge copper wire, of a certain determinate length, was about 1,400 miles per second; the mean or average speed of the magneto-electric current in a similar wire of equal length was about 4,300 miles per second. The maximum speed attained by voltaic electricity was 1,800 miles per second; the maximum for the magneto-electric current was 6,000 miles per second. There could be no doubt, after these experiments, that *the magneto-electric current issuing from induction coils gives a treble velocity of electrical transmission, and therefore realizes a three-fold working speed.*

Professor Faraday has shown that no augmentation of velocity results from the use of an increased amount of battery-power in the simple voltaic arrangement, up to the employment of twenty times the number of plates used at the first. In this particular again the double induction current established for itself a marked superiority. This current can have the speed augmented by increased amount of battery power. This was remarkably proved by an inverse inference in one observation, in which there was a steady and gradual diminution of velocity from 5,400 to 3,600 miles per second, during the spontaneous exhaustion of a small Grove's battery, employed in exciting a series of magnetic induction coils. Increased quantity in this arrangement tells by filling the thick wire of the primary coil to its full capacity, and this produces increased polar force in the temporary magnet, and increased inductive excitement in the finer secondary coil.

Experiment demonstrates that the velocity of an electric current diminishes with progress along a lengthened gutta percha coated wire, more nearly in the proportion of an arithmetical series, than in that of the squares

of the units of distance travelled. The retardation practically *does* in a measure exceed the simple arithmetical ratio of units of distance traversed; but this departure from the law of the simple series is in all probability due to the retardation caused in the further portions of the conducting wire by the increasingly exhausted condition of the weakened stream. When the amount of electro motive force is fairly proportioned to the length of the wire, a more uniform rate of propagation in the several parts of a continuous extent is found than is the case when an adequate amount of electrical influence is employed.

When the notion was first brought prominently forward that the electrical influence *ought* to pass along telegraphic wires with a velocity proportional in reverse ratio to the square of the length of the wire, an hypothetical plan was proposed for practically getting over this difficulty. This plan was, to make the road for the electrical current of easier access, by *rendering it larger.* It was conceived that if one wire was required to transmit signals with equal facility and speed to another which was only one-sixth part as long, the longer wire should be made of at least *six times* the capacity of the shorter one.

It was obviously a matter of primary importance to the cause of Atlantic telegraphy that the deductions of this theory should be put to rigid experimental proof, because, if they were correct, so large and ponderous a cable would be required to carry even a single conductor, that the manufacture and deposit in the Atlantic depths of such an unwieldy mass would be an affair that must prove of exceeding difficulty and cost, if not, indeed, altogether impracticable. The Calais and Dover cable weighs eight tons per mile; the entire weight of a cable for Atlantic service, of only the same dimensions as this, would be at least 20,000 tons. As, therefore, the Atlantic Cable would be required by theory considerably to exceed this, it is plain that not even Scott Russell's Leviathan ship, which will be able to move over the waves with an army of ten thousand men upon her decks, could carry it to its destination. In the unsuccessful attempt to lay down the Mediterranean cable, it was found to be a task of extreme difficulty, and even danger, to manage the mechanical parts of the operation, owing to the great weight of the cable held in suspension, and the vast strength and grip of machinery required to suspend. It may, therefore, be easily imagined what the task would be with a cable weighing some ten tons per mile. The weight in Atlantic depths, dependent upon itself, and hanging from the ship and machinery would with it exceed twenty tons; an amount equally inconvenient and dangerous to the cohesion of the structure, and to the capabilities of the apparatus used in paying out.

The first experimental investigations upon this point comprised a series of not less than two thousand observations. The experimenter worked with a three hundred miles length of wire, which he was enabled so to double and treble at will, that it became for the time virtually a wire of twice or three times the original capacity. The result was that it appeared the wire of increased capacity *did not transmit electrical signals with greater facility* and speed than the smaller one. With a length of 166 miles, the velocity

of movement of the simple voltaic current came out .16 of a second for a single wire; .21 of a second for a double one, and .28 for a treble one. With the same length, the velocity of the double induction current came out for the single wire, .08; with the double one, .09; and with the treble one .095 of a second. With a length of 250 miles, the velocity was for voltaic electricity, .29 and .406 of a second for a single and double wire respectively, and for the double induction current .145 and .185 of a second. The fact thus actually is, that *increasing the size of the conductor augments retardation* in the transmission of electricity through it. A treble-sized conductor gives nearly a doubled rate of retardation.

The general conclusion drawn from the important investigation of the assumption that electrical currents would move in submarine circuits with velocities that were in inverse ratio to the squares of the lengths of the circuits, seems to be that *Nature recognizes the existence of no such law.* "The *law of the squares*" may possibly apply to the transmission of electricity freely along simple conducting wires, but *it certainly does not apply to the case of its transmission along submarine or subterranean gutta percha covered wire,* (the facility of transmission being estimated by rate of speed), because in this the case is not one of simple conduction, but of transmission after the wire has been charged inductively to saturation as a Leyden jar.

As the result of all the investigations the following points may be considered as established: —

That gutta percha covered submarine wires do not transmit as simple insulated conductors, but that they have to be charged as Leyden jars, before they can transmit at all.

That, consequently, such wires transmit with a velocity that is in no way accordant to the movement of the electrical current in an unembarrassed way along simple conductors.

That magneto-electric currents travel more quickly along such wires than simple voltaic currents.

That magneto-electric currents travel more quickly when in high energy than when in low, although voltaic currents of large intensity do not travel more quickly than voltaic currents of small intensity.

That the velocity of the transmission of signals along insulated submerged wires can be enormously increased, from the rate indeed of one in two seconds, to the rate of eight in a single second, by making each alternate signal with a current of different quality, positive following negative, and negative following positive.

That the diminution of the velocity of the transmission of a magneto-electric current in induction-embarrassed coated wires, is not in the inverse ratio of the squares of the distance traversed, but much more nearly in the ratio of simple arithmetical progression.

The several distinct waves of electricity may be travelling along different parts of a long wire simultaneously, and within certain limits, without interference.

That large coated wires used beneath the water or the earth are worse conductors, so far as velocity of transmission is concerned. than small ones,

and therefore are not so well suited as small ones for the purposes of submarine transmission of telegraphic signals; and

That by the use of comparatively small coated wires, and of electro-magnetic induction-coils for the exciting agents, telegraphic signals can be transmitted through two thousand miles with a speed amply sufficient for all commercial and economical purposes.

ON THE DEPOSITION OF THE ATLANTIC TELEGRAPH CABLE.

In a discussion which took place at the last meeting of the British Association, on the deposition of the Atlantic Telegraph Cable, and its arrangement upon the bottom, it seemed to be universally admitted that it was mathematically impossible, unless the speed of the vessel from which the cable was payed out could be almost infinitely increased, to lay out a cable in deep waters (say two miles or more) in such a way as not to require a length much greater than that of the actual distance, as from the inclined direction of the yet sinking part of the cable, the successive portions payed out must, when they reached the bottom, arrange themselves in wavy folds; since the actual length is greater than the entire horizontal distance. The fact, therefore, which, when noticed, led to the increasing of the strain on the Atlantic cable until it broke ought to have been anticipated, and must be provided for in the future progress of that great national undertaking.

GRAHAM'S IMPROVED MAGNETIC COMPASS.

In this recently patented compass, by Capt. Graham, of England, the local attraction in iron vessels is counteracted by means of a series of permanent magnets. Instead of being laid down on the deck as in the old plan of adjustment, these magnets, four or five in number, are disposed on a frame round the compass and on a level with the card, and are so arranged as to bring their polarities into correlative lines. Each magnet is fitted with a screw, by which it may be brought nearer to or drawn back from the compass by simply turning a small key. The effect of these magnets is to surround the compass with a well balanced and tensible force which cuts off or neutralizes all local derangements. Whatever the amount of disturbance may be, the magnets can be so brought to bear upon the compass as to overcome it. Great steadiness is thus imparted to the needle, preserved as it is from oscillation by invisible threads of influence issuing from the magnets, while at the same time what is called "the sluggishness" of the needle is dissipated, its energy and sensitiveness are increased, or in other words it is rendered more susceptible of influence by the natural magnetic current, and consequently a more prompt and truthful indicator of any alteration in the ship's course.

IMPROVEMENTS IN THE ELECTROTYPE PROCESS.

At the Dublin meeting of the British Association M. L'Abbe Moigno read a very interesting paper "On three new Electrotype Processes," and

exhibited several specimens. The first of these consisted in the employment of platina instead of copper, and of making a skeleton figure roughly resembling the outline of the cast sought to be attained, by means of which, according to the lecturer's process, can be produced busts, statues, and groups in full relief by a single operation. The second process was for galvanizing or coppering iron and cast iron to any thickness required without the cyanide bath, and its employment in commerce and in the navy. The process was not fully communicated, as it is commercially desirous to keep it a secret, but sufficient was communicated to show that the cyanide bath, which is not only expensive but dangerous, can be dispensed with. The last branch of the paper treated of Messrs. Christofi and Bouillet's process for strengthening electrotypes, the principle of which was to leave an opening in the back of the thin electrotype, obtained by precipitating it, and by putting it into a number of small pieces of brass, which, on being melted with an oxhydrogen blast, become diffused all over the interior of the copper without injuring it in any way, and thereby imparting to it the strength of cast iron.

RECENT PROGRESS OF TERRESTRIAL MAGNETISM.

It has been long known that the elements of the earth's magnetic force were subject to certain regular and recurring changes, whose periods were, respectively, a *day* and a *year*, and which, therefore, were referred to the sun as their source. To these periodical changes Dr. Lamont, of Munich, added another of *ten years*, the diurnal range of the magnetic declination having been found to pass from a maximum to a minimum, and back again, in about that time. But besides these slow and regular changes, there are others of a different class, which recur at *irregular* intervals, and which are characterized by a large deviation of the magnetic elements from their normal state, and generally also by rapid fluctuation and change. These phenomena, called by Humboldt "magnetic storms" have been observed to occur *simultaneously* in the most distant parts of the earth, and therefore indicate the operation of causes affecting the entire globe. But, casual as they seem, they are found to be subject to laws of their own. Professor Kreil was the first to discover that, at a given place, they recurred more frequently at certain hours of the day than at others; and that, consequently, in their *mean effects*, they were subject to *periodical laws*, depending upon the *hour* at each station. The laws of this periodicity have been ably worked out by General Sabine in his discussion of the results of the British Colonial Observatories; and he has added the important facts, that the same phenomena observe also the two other periods already noticed, — namely, the *annual* and the *decennial* periods. He has further arrived at the very remarkable result, that the decennial magnetic period coïncides, both in its duration and in its epochs of maxima and minima, with the decennial period observed by Schwabe in the solar spots; from which it is to be inferred that the sun exercises a magnetic influence upon the earth dependent on the condition of its luminous envelop. We are thus in the presence of two facts, which appear

at first sight opposed — namely, the *absolute simultaneity* of magnetic disturbances at all parts of the earth, and their *predominance at certain local hours* at each place. General Sabine accounts for this apparent discrepancy by the circumstance, that the hours of maximum disturbance are different for the different elements; so that there may be an abnormal condition of the magnetic force, operating at the same instant over the whole globe, but manifesting itself at one place chiefly in one element, and at another place in another. I would venture to suggest, as a subject of inquiry, whether the phenomena which have been hitherto grouped together as "occasional" effects, may not possibly include two distinct classes of changes, obeying separate laws — one of them being strictly *periodic*, and constituting a part of the regular diurnal change; while the other is strictly *abnormal* and *simultaneous*. If this be so, it would follow that we are not justified in separating the larger changes from the rest, merely on the ground of their magnitude, and that a different analysis of the phenomenon will be required. The effects hitherto considered are all referrable to the sun as their cause. Prof. Kreil discovered, however, that another body of our system — namely, our own satellite — exerted an effect upon the magnetic needle, and that the magnetic declination underwent a small and very regular variation, whose amount was dependent on the lunar hour-angle, and whose period was therefore a lunar day. This singular result was subsequently confirmed by Mr. Broun in his discussion of the Makerstown Observations; and its laws have since been fully traced, for all the magnetic elements, by General Sabine, in the results obtained at the Colonial Magnetic Observatories. The foregoing facts bear closely upon the debated question of the causes of the magnetic variations. It has been usual to ascribe the periodical changes of the earth's magnetic force to the thermic action of the sun, operating either *directly* upon the magnetism of the earth, or affecting it *indirectly* by the induction of the thermo-electric currents. Here, however, we have a distinct case of magnetic action, unaccompanied by heat; and the question is naturally suggested, whether the solar diurnal change may not also be independent of temperature. The most important fact, in its bearing upon this question, is the existence of an *annual inequality* in the diurnal variation, dependent on the sun's declination, recently pointed out by General Sabine. If we deduct the ordinate of the curve which represents the mean diurnal variation for the entire year, from those for the summer and winter half-yearly curves respectively, the differences are found to be equal and opposite; and the curves which represent them are, consequently, similar, but oppositely placed, with respect to the axis of abscissæ. From this, General Sabine draws the inference, that the diurnal variation is a *direct effect of solar action*, and not a result of its thermic agency. — *Pres. Loyd's Address before the British Association.*

ON THE ORIGIN AND CAUSE OF THE AURORA BOREALIS.

At the Montreal meeting of the A. A. A. S., Prof. Olmstead presented briefly his views respecting the origin and cause of the aurora borealis. Contrary to the opinion which ascribes it to terrestrial agents, as electricity or magnet-

ism, he argued that the origin of the aurora was cosmical, the matter of which it was composed being derived from the planetary spaces. He inferred this cosmical origin, from the following reasons: First, from the great extent of the exhibitions, sometimes spreading from east to west, for many thousand miles, and rushing to a height of a hundred miles and more, quite above the region of atmospheric precipitation. Secondly, from the fact that in places differing many degrees of longitude, the different stages of the aurora (beginning, maximum and end) occur at the same hour of the night, indicating that a place on the earth, in its diurnal revolution, comes successively under the nearest point of the auroral body situated in space. Thirdly, from the velocity of the motions, being too small for light itself, but too great to result from any known terrestrial force, as magnetic or electrical fractions, occasioning a translation of the matter of the aurora. Fourthly, from the periodicity of the aurora, especially its secular periodicity, appearing at long but nearly definite intervals in a grand series of exhibitions, which increase to a maximum and then diminish in number and intensity, until the phenomenon, in its grandest forms, vanishes from our nocturnal heavens,—a fact which appears to remove it from the pale of terrestrial, and to bring it clearly within the domain of astronomical causes, implying a nebulous body in the planetary spaces, from which the material of the aurora is derived, having a revolution around the sun, and a period in a nearly simple ratio to the earth's periods.

At the Dublin meeting of the British Association, Capt. Maguire, who commanded the Plover, sent out in search of Sir John Franklin, *via* of Bhering's Straits, in the course of a discussion, said he wished he could convey to the meeting any vivid impressions of the beauty of the aurora as witnessed at Point Barrow, the most northern cape of that part of the American continent which lies between Bhering's Straits and Mackenzie's River. It was never seen during the hours of daylight, or those hours which corresponded to mid-day, but towards evening its displays began, at first towards the north; it then extended in splendid arches spanning the entire sky, and seeming to end in beautiful coronæ towards the zenith; these were occasionally of the most brilliant and varied tints and colors. It spread gradually more south, and at length died away towards the morning hours in the south. Such were the beauty and interest of these displays, that men and officers constantly, with the thermometer at and below forty degrees below zero, stood out for hours witnessing the glorious scene. During these auroral displays he could not say that he had ever witnessed those violent agitations of the needle that others had described, but the easterly disturbance of the variation seemed to be simultaneous with its northerly display, and the westerly to its influence when it had passed to the south. At some distance from the ships, say about five miles, the water shoaled, and the ice had been driven up into beautiful rocky pinnacles; beyond this, again, the water was always free of ice, and its temperature was frequently found to be twenty-eight degrees above zero, when that of the air above was even forty degrees below zero; the consequence was, that it had all the appearance of a boiling sea, so great was the quantity of vapor thrown up from it.

ON THE DISPOSITION OF FORCE IN PARAMAGNETIC AND DIAMAGNETIC BODIES.

The following is an abstract of a lecture on the above subject, recently delivered before the Royal Institution of Great Britain, by Prof. Tyndall, F. R. S.: —

The motion of an attractive force, which draws bodies towards the centre of the earth, was entertained by Anaxagoras and his pupils, by Democritus, Pythagoras, and Epicurus; and the conjectures of these ancients were renewed by Galileo, Huyghens, and others, who stated that bodies attract each other as a magnet attracts iron. Kepler applied the notion to bodies beyond the surface of the earth, and affirmed the extension of this force to the most distant stars. Thus it would appear, that in the attraction of iron by a magnet originated the conception of the force of gravitation. Nevertheless, if we look closely at the matter, it will be seen that the magnetic force possesses characters strikingly distinct from those of the force which holds the universe together. The theory of gravitation is, that every particle of matter attracts every other particle; in magnetism also we have the phenomenon of attraction, but we have also, at the same time, the fact of repulsion, and the final effect is always due to the difference of these two forces. A body may be intensely acted on by a magnet, and still no motion of translation will follow, if the repulsion be equal to the attraction. A dipping needle was exhibited; previous to magnetization, the needle, when its centre of gravity was supported, stood accurately level; but, after magnetization, one end of it was pulled towards the north pole of the earth. The needle, however, being suspended from the arm of a fine balance, it was shown that its weight was unaltered by its magnetization. In like manner, when the needle was permitted to float upon a liquid, and thus to follow the attraction of the north magnetic pole of the earth, there was no motion of the mass towards the pole referred to; and the reason was known to be, that although the marked end of the needle was attracted by the north pole, the unmarked end was repelled by an equal quantity, and these two equal and opposite forces neutralized each other as regards the production of a motion of translation. When the pole of an ordinary magnet was brought to act upon the swimming needle, the latter was attracted, — the reason being that the attracted end of the needle being much nearer to the pole of the magnet than the repelled end, the force of attraction was the more powerful of the two; but in the case of the earth, the pole being so distant, the length of the needle was practically zero. In like manner, when a piece of iron is presented to a magnet, the nearer parts are attracted, while the more distant parts are repelled; and because the attracted portions are nearer to the magnet than the repelled ones, we have a balance in favor of attraction. Here, then, is the most wonderful characteristic of the magnetic force, which distinguishes it from that of gravitation. The latter is a simple unpolar force, while the former is duplex or polar. Were gravitation like magnetism, a stone would no more fall to the ground than a piece of iron towards the north magnetic pole; and thus, however rich in consequences the supposi-

tion of Kepler and others may have been, it was clear that a force like that of magnetism would not be able to transact the business of the universe.

The object of the evening's discourse was to inquire whether the force of diamagnetism, which manifested itself as a repulsion of certain bodies by the poles of a magnet, was to be ranged as a polar force, beside that of magnetism; or as an unpolar force, beside that of gravitation.

By means of a beautifully-devised piece of apparatus, which cannot well be explained without a diagram, Prof. Tyndall was enabled to experimentally prove that the force of diamagnetism was a polar force, precisely antithetical to the force of magnetism. The diamagnetic substance operated on in the first instance, was bismuth, but the same action was found to take place with various other substances, as phosphorus, nitre, sulphur, calcareous spar, statuary marble, etc., each of these substances was proved polar, the disposition of the force being the same as that of bismuth and the reverse of that of iron. When a bar of iron is set erect, its lower end is known to be a north pole, and its upper end a south pole, in virtue of the earth's induction. A marble statue, on the contrary, has its feet a south pole, and its head a north pole, and there is no doubt that the same remark applies to its living archetype; each man walking over the earth's surface is a true diamagnet, with its poles the reverse of those of a mass of magnetic matter of the same shape and in a similar position.

ON THE CONSERVATISM OF FORCE.

The following lecture by Prof. Faraday, before the Royal Institution, is one of the most interesting contributions made to physical science during the past year. The reputation and experience of the author, the interest felt by all scientific men in his communications, and the fact that the paper has not hitherto been republished in the United States, are reasons for its entire reproduction in the pages of the Annual of Scientific Discovery. — EDITOR.

Various circumstances induce me at the present moment to put forth a consideration regarding the conservation of force. I do not suppose that I can utter any truth respecting it that has not already presented itself to the high and piercing intellects which move within the exalted regions of science; but the course of my own investigations and views makes me think that the consideration may be of service to those persevering laborers (amongst whom I endeavor to class myself) who, occupied in the comparison of physical ideas with fundamental principles, and continually sustaining and aiding themselves by experiment and observation, delight to labor for the advance of natural knowledge, and strive to follow it into undiscovered regions.

There is no question which lies closer to the root of all physical knowledge than that which inquires whether force can be destroyed or not. The progress of the strict science of modern times has tended more and more to produce the conviction that "force can neither be created nor destroyed;" and to render daily more manifest the value of the knowledge of that truth in experimental research. To admit, indeed, that force may be destructible

or can altogether disappear, would be to admit that matter could be uncreated; for we know matter only by its forces; and though one of these is most commonly referred to, namely, gravity, to prove its presence, it is not because gravity has any pretension, or any exemption, amongst the forms of force as regards the principle of *conservation*, but simply that being, as far as we perceive, inconvertible in its nature and unchangeable in its manifestation, it offers an unchanging test of the matter which we recognize by it.

Agreeing with those who admit the conservation of force to be a principle in physics, as large and sure as that of the indestructibility of matter, or the invariability of gravity, I think that no particular idea of force has a right to unlimited or unqualified acceptance that does not include *assent* to it; and also, to *definite amount* and *definite disposition of the force*, either in one effect or another, for these are necessary consequences; therefore I urge, that the conservation of force ought to be admitted as a physical principle in all our hypotheses, whether partial or general, regarding the actions of matter. I have had doubts in my own mind whether the considerations I am about to advance are not rather metaphysical than physical. I am unable to define what is metaphysical in physical science; and am exceedingly adverse to the easy and unconsidered admission of one supposition upon another, suggested as they often are by very imperfect induction from a small number of facts, or by a very imperfect observation of the facts themselves; but, on the other hand, I think the philosopher may be bold in his application of principles which have been developed by close inquiry, have stood through much investigation, and continually increase in force. For instance, *time* is growing up daily into importance as an element in the exercise of force. The earth moves in its orbit in time; the crust of the earth moves in time; light moves in time; an electro-magnet requires time for its charge by an electric current; to inquire, therefore, whether power, acting either at sensible or insensible distances, always acts in *time*, is not to be metaphysical; if it acts in time and across space, it must act by physical lines of force; and our view of the nature of the force may be affected to the extremest degree by the conclusions which experiment and observation on time may supply; being, perhaps, finally determinable only by them. To inquire after the possible time in which gravitating, magnetic, or electric force is exerted, is no more metaphysical than to mark the times of the hands of a clock in their progress; or that of the temple of Serapis and its ascents and descents; or the periods of the occultations of Jupiter's satellites; or that in which the light from them comes to the earth. Again, in some of the known cases of action in time, something happens whilst the *time* is passing which did not happen before, and does not continue after; it is, therefore, not metaphysical to expect an effect in *every* case, or to endeavor to discover its existence and determine its nature. So in regard to the principle of the conservation of force; I do not think that to admit it, and its consequences, whatever they may be, is to be metaphysical; on the contrary, if that word have any application to physics, then I think that any hypothesis, whether of heat, or electricity, or gravitation, or any other form of force, which either willingly or unwillingly dispenses with the principle of conserv-

ation, is more liable to the charge than those which, by including it, become so far more strict and precise.

Supposing that the truth of the principle of the conservation of force is assented to, I come to *its uses.* No hypothesis should be admitted, nor any assertion of a fact credited, that denies the principle. No view should be inconsistent or incompatible with it. Many of our hypotheses in the present state of science may not comprehend it, and may be unable to suggest its consequences; but none should oppose or contradict it.

If the principle be admitted, we perceive at once that a theory or definition, though it may not contradict the principle, cannot be accepted as sufficient or complete unless the former be contained in it; that however well or perfectly the definition may include and represent the state of things commonly considered under it, that state or result is only partial, and must not be accepted as exhausting the power or being the full equivalent, and therefore cannot be considered as representing its *whole nature;* that, indeed, it may express only a very small part of the whole, only a residual phenomenon, and hence give us but little indication of the full natural truth. Allowing the principle its force, we ought, in every hypothesis, either to account for its consequences by saying what the changes are when force of a given kind apparently disappears, as when ice thaws, or else should leave space for the idea of the conversion. If any hypothesis, more or less trustworthy on other accounts, is insufficient in expressing it or incompatible with it, the place of deficiency or opposition should be marked as the most important for examination, for there lies the hope of a discovery of new laws or a new condition of force. The deficiency should never be accepted as satisfactory, but be remembered and used as a stimulant to further inquiry; for conversions of force may here be hoped for. Suppositions may be accepted for the time, provided they are not in contradiction with the principle. Even an increased or diminished capacity is better than nothing at all, because such a supposition, if made, must be consistent with the nature of the original hypothesis, and may, therefore, by the application of experiment, be converted into a further test of probable truth. The case of a force simply removed or suspended, without a transferred exertion in some other direction, appears to me to be absolutely impossible.

If the principle be accepted as true, we have a right to pursue it to its consequences, no matter what they may be. It is, indeed, a duty to do so. A theory may be perfection, as far as it goes, but a consideration going beyond it, is not for that reason to be shut out. We might as well accept our limited horizon as the limits of the world. No magnitude, either of the phenomena or of the results to be dealt with, should stop our exertions to ascertain, by the use of the principle, that something remains to be discovered, and to trace in what direction that discovery may lie.

I will endeavor to illustrate some of the points which have been urged, by reference, in the first instance, to a case of power, which has long had great attractions for me, because of its extreme simplicity, its promising nature, its universal presence, and its invariability under like circumstances; on which,

though I have experimented * and as yet failed, I think experiment would be well bestowed, I mean the force of gravitation. I believe I represent the received idea of the gravitating force aright in saying that it is *a simple attractive force exerted between any two or all the particles or masses of matter, at every sensible distance, but with a strength varying inversely as the square of the distance.* The usual idea of the force implies *direct* action at a distance; and such a view appears to present little difficulty except to Newton, and a few, including myself, who in that respect may be of like mind with him. †

This idea of gravity appears to me to ignore entirely the principle of the conservation of force; and by the terms of its definition, if taken in an absolute sense, "*varying* inversely as the square of the distance," to be in direct opposition to it, and it becomes my duty now to point out where this contradiction occurs, and to use it in illustration of the principle of conservation. Assume two particles of matter, A and B, in free space, and a force in each or in both by which they gravitate towards each other, the force being unalterable for an unchanging distance, but varying inversely as the square of the distance when the latter varies. Then, at the distance of ten, the force may be estimated as one; whilst at the distance of one, that is, one tenth of the former, the force will be one hundred; and if we suppose an elastic spring to be introduced between the two as a measure of the attractive force, the power compressing it will be a hundred times as much in the latter case as in the former. But from whence can this enormous increase of power come? If we say that it is the character of this force, and content ourselves with that as a sufficient answer, then it appears to me we admit a *creation* of power and that to an enormous amount; yet by a change of condition, so small and simple as to fail in leading the least instructed mind to think that it can be a sufficient cause, we should admit a result which would equal the highest act our minds can appreciate of the working of infinite power upon matter; we should let loose the highest law in physical science which our faculties permit us to perceive, namely, the *conservation of force.* Suppose the two particles, A and B, removed back to the greater distance of ten, then the force of attraction would be only a hundredth part of that they previously possessed; this, according to the statement that the force varies inversely as the square of the distance would double the strangeness of the above results; it would be an *annihilation* of force — an effect equal in its infinity and its consequences with *creation,* and only within the power of Him who has created.

We have a right to view gravitation under every form that either its definition or its effects can suggest to the mind; it is our privilege to do so with every force in nature; and it is only by so doing that we have succeeded, to a large extent, in relating the various forms of power, so as to derive one from another, and thereby obtain confirmatory evidence of the great principle of the conservation of force. Then let us consider the two particles, A and B, as attracting each other by the force of gravitation, under another view. According to the definition, the force depends upon both particles, and if the

* Philosophical Transactions, 1851, p. 1.

† See second note on page 183.

particle A or B were by itself, it could not gravitate, that is, it could have no attraction, no *force* of gravity. Supposing A to exist in that isolated state and without gravitating force, and then B placed in relation to it, gravitation comes on, as is supposed, on the part of both. Now, without trying to imagine *how* B, which had no gravitating force, can raise up gravitating force in A; and how A, equally without force beforehand, can raise up force in B, still, to imagine it as a fact done, is to admit a creation of force in both particles; and so to bring ourselves within the impossible consequences which have already been referred to.

It may be said we cannot have an idea of one particle by itself, and so the reasoning fails. For my part I can comprehend a particle by itself just as easily as many particles; and though I cannot conceive the relation of a lone particle to gravitation, according to the limited view which is at present taken of that force, I can conceive its relation to something which causes gravitation, and with which, whether the particle is alone, or one of a universe of other particles, it is always related. But the reasoning upon a lone particle does not fail; for as the particles can be separated, we can easily conceive of the particle B being removed to an infinite distance from A, and then the power in A will be infinitely diminished. Such removal of B will be as if it were annihilated in regard to A, and the force in A will be annihilated at the same time; so that the case of a lone particle and that were different distances only are considered become one, being identical with each other in their consequences. And as removal of B to an infinite distance is as regards A annihilation of B, so removal to the smallest degree is, in principle, the same thing with displacement through infinite space; the smallest increase in distance involves annihilation of power; the annihilation of the second particle, so as to have A alone, involves no other consequence in relation to gravity; there is difference in degree, but no difference in the character of the result.

It seems hardly necessary to observe, that the same line of thought grows up in the mind, if we consider the mutual gravitating action of one particle and many. The particle A will attract the particle B at the distance of a mile with a certain degree of force; it will attract a particle C at the same distance of a mile with a power equal to that by which it attracts B; if myriads of like particles be placed at the given distance of a mile, A will attract each with equal force; and if other particles be accumulated round it, within and without the sphere of two miles diameter, it will attract them all with a force varying inversely with the square of the distance. How are we to conceive of this force growing up in A to a million fold or more, and if the surrounding particles be then removed, of its diminution in an equal degree? Or, how are we to look upon the power raised up in all these outer particles by the action of A on them, or by their action one on another, without admitting, according to the limited definition of gravitation, the facile generation and annihilation of force?

The assumption which we make for the time with regard to the nature of a power (as gravity, heat, etc.), and the form of words in which we express it, that is, its definition, should be consistent with the fundamental principles

of force generally. The conservation of force is a fundamental principle; hence the assumption with regard to a particular form of force ought to imply what becomes of the force when its action is *increased* or *diminished*, or its *direction changed;* or else the assumption should admit that it is deficient on that point, being only half competent to represent the force; and, in any case, should not be opposed to the principle of conservation. The usual definition of gravity as *an attractive force between the particles of matter* VARYING *inversely as the square of the distance*, whilst it stands as a full definition of the power, is inconsistent with the principle of the conservation of force. If we accept the principle, such a definition must be an imperfect account of the whole of the force, and is probably only a description of one exercise of that power, whatever the nature of the force itself may be. If the definition be accepted as tacitly including the conservation of force, then it ought to admit that consequences must occur during the suspended or diminished degree in its power as gravitation, equal in importance to the power suspended or hidden; being in fact equivalent to that diminution. It ought also to admit, that it is incompetent to suggest or deal with any of the consequences of that changed part or condition of the force, and cannot tell whether they depend on, or are related to, conditions *external* or *internal* to the gravitating particle; and, as it appears to me, can say neither yes nor no to any of the arguments or probabilities belonging to the subject.

If the definition *denies* the occurrence of such contingent results, it seems to me to be unphilosophical; if it simply *ignores* them, I think it is imperfect and insufficient; if it *admits* these things, or any part of them, then it prepares the natural philosopher to look for effects and conditions as yet unknown, and is open to any degree of development of the consequences and relations of power; by denying, it opposes a dogmatic barrier to improvement; by ignoring, it becomes in many respects an inert thing, often much in the way; by admitting, it rises to the dignity of a stimulus to investigation, a pilot to human science.

The principle of the conservation of force would lead us to assume, that when A and B attract each other less because of increasing distance, then some other exertion of power, either within or without them, is proportionately growing up; and again, that when their distance is diminished, as from ten to one, the power of attraction, now increased a hundred-fold, has been produced out of some other form of power which has been equivalently reduced. This enlarged assumption of the nature of gravity is not more metaphysical than the half assumption; and is, I believe, more philosophical and more in accordance with all physical considerations. The half assumption is, in my view of the matter, more dogmatic and irrational than the whole, because it leaves it to be understood that power can be created and destroyed almost at pleasure.

When the equivalents of the various forms of force, as far as they are known, are considered, their differences appear very great; thus, a grain of water is known to have electric relations equivalent to a very powerful flash of lightning. It may therefore be supposed that a very large apparent amount of the force causing the phenomena of gravitation, may be the

equivalent of a very small change in some unknown condition of the bodies, whose attraction is varying by change of distance. For my own part, many considerations urge my mind toward the idea of a cause of gravity, which is not resident in the particles of matter merely, but constantly in them, and all space. I have already put forth considerations regarding gravity which partake of this idea,* and it seems to have been unhesitatingly accepted by Newton.†

There is one wonderful condition of matter, perhaps its only true indication, namely, *inertia;* but in relation to the ordinary definition of gravity, it only adds to the difficulty. For if we consider two particles of matter at a certain distance apart, attracting each other under the power of gravity, and free to approach, they will approach; and when at only half the distance, each will have had stored up in it, because of its *inertia*, a certain amount of mechanical force. This must be due to the force exerted, and, if the conservation principle be true, must have consumed an equivalent proportion of the cause of attraction; and yet, according to the definition of gravity, the attractive force is not diminished thereby, but increased four-fold, the force growing up within itself the more rapidly, the more it is occupied in producing other force. On the other hand, if mechanical force from without be used to separate the particles to twice their distance, this force is not stored up in momentum or by inertia, but disappears; and three fourths of the attractive force at the first distance disappears with it. How can this be?

We know not the physical condition or action from which *inertia* results; but inertia is always a pure case of the conservation of force. It has a strict relation to gravity, as appears by the proportionate amount of the force which gravity can communicate to the inert body; but it appears to have the same strict relation to other forces acting at a distance as those of magnetism or electricity, when they are so applied by the tangential balance as to act independent of the gravitating force. It has the like strict relation to force communicated by impact, pull, or in any other way. It enables a body to take up and conserve a given amount of force until that force is transferred to other bodies, or changed into an equivalent of some other form; that is all that we perceive in it; and we cannot find a more striking instance amongst natural, or possible phenomena of the necessity of the conservation of force as a law of nature; or one more in contrast with the assumed variable condition of the gravitating force supposed to reside in the particles of matter.

Even gravity itself furnishes the strictest proof of the conservation of force

* Proceedings of the Royal Institution, 1855, vol. ii., p. 10, etc.

† "That gravity should be innate, inherent, and essential to matter, so that one body may act upon another at a distance, through a *vacuum*, without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity that I believe, no man who has in philosophical matters a competent faculty of thinking, can ever fall into it. Gravity must be caused by an agent, acting constantly according to certain laws; but whether this agent be material or immaterial I have left to the consideration of my reader." — *See Newton's Third Letter to Bentley.*

in this, that its power is unchangeable for the same distance; and is by that in striking contrast with the variation which we assume in regard to the *cause of gravity*, to account for the *results* at different distances.

It will not be imagined for a moment that I am opposed to what may be called the *law of gravitating action*, that is, the law by which all the known effects of gravity are governed; what I am considering is the definition of the *force* of gravitation. That the result of one exercise of a power may be inversely as the square of the distance, I believe and admit; and I know that it is so in the case of gravity, and has been verified to an extent that could hardly have been within the conception even of Newton himself when he gave utterance to the law; but that the *totality* of a force can be employed according to that law I do not believe, either in relation to gravitation, or electricity, or magnetism, or any other supposed form of power.

I might have drawn reasons for urging a continual recollection of, and reference to, the principle of the conservation of force from other forms of power than that of gravitation; but I think that when founded on gravitating phenomena, they appear in their greatest simplicity; and precisely for this reason, that gravitation has not yet been connected by any degree of convertibility with the other forms of force. If I refer for a few minutes to these other forms, it is only to point in their variations, to the proofs of the value of the principle laid down, the consistency of the known phenomena with it, and the suggestions of research and discovery which arise from it.* *Heat*, for instance, is a mighty form of power, and its effects have been greatly developed; therefore, assumptions regarding its nature become useful and necessary, and philosophers try to define it. The most probable assumption is. that it is a motion of the particles of matter; but a view, at one time very popular, is, that it consists of a particular fluid of heat. Whether it be viewed in one way or the other, the principle of conservation is admitted, I believe, with all its force. When transferred from one portion to another portion of like matter, the full amount of heat appears. When transferred to matter of another kind an apparent excess or deficiency often results; the word "capacity" is then introduced, which, while it acknowledges the principle of conservation, leaves space for research. When employed in changing the state of bodies, the appearance and disappearance of the heat is provided for consistently by the assumption of enlarged or diminished motion, or else space is left by the term "capacity" for the partial views which remain to be developed. When converted into mechanical force, in the steam or air engine, and so brought into direct contact with gravity, being then easily placed in relation to it, still the conservation of force is fully respected and wonderfully sustained. The constant amount of heat developed in the whole of a voltaic current described by M. P. Favre,† and the present state of the knowledge of thermo-electricity, are again fine, partial or subordinate illustrations of the principles of

Helmholtz, on the Conservation of Force. Taylor's Scientific Memoirs, Second Sesies, 1853, p. 114.

† Comptes Rendus, 1854, vol. xxxix. p. 1212.

conservation. Even when rendered radiant, and for the time giving no trace or signs of ordinary heat action, the assumptions regarding its nature have provided for the belief in the conservation of force, by admitting either that it throws the ether into an equivalent state, in sustaining which for the time the power is engaged; or else, that the motion of the particles of heat is employed altogether in their own transit from place to place.

It is true that heat often becomes evident or insensible in a manner unknown to us; and we have a right to ask what is happening when the heat disappears in one part, as of the thermo-voltaic current, and appears in another; or when it enlarges or changes the state of bodies; or what would happen, if the heat being presented, such changes were purposely opposed. We have a right to ask these questions, but not to ignore or deny the conservation of force; and one of the highest uses of the principle is to suggest such inquiries. Explications of similar points are continually produced, and will be most abundant from the hands of those who, not desiring to ease their labor by forgetting the principle, are ready to admit it, either tacitly, or, better still, effectively, being then continually guided by it. Such philosophers believe that heat must do its equivalent of work; that if in doing work it seem to disappear, it is still producing its equivalent effect, though often in a manner partially or totally unknown; and that if it give rise to another form of force (as we imperfectly express it), that force is equivalent in power to the heat which has disappeared.

What is called *chemical attraction* affords equally instructive and suggestive considerations in relation to the principle of the conservation of force. The indestructibility of individual matter is one case, and a most important one, of the conservation of chemical force. A molecule has been endowed with powers which give rise in it to various qualities, and these never change, either in their nature or amount. A particle of oxygen is ever a particle of oxygen — nothing can in the least wear it. If it enters into combination and disappears as oxygen, — if it pass through a thousand combinations, animal, vegetable, mineral, — if it lie hid for a thousand years and then be evolved, it is oxygen with its first qualities, neither more nor less. It has all its original force, and only that; the amount of force which it disengaged when hiding itself has again to be employed in a reverse direction when it is set at liberty; and if, hereafter, we should decompose oxygen, and find it compounded of other particles, we should only increase the strength of the proof of the conservation of force, for we should have a right to say of these particles, long as they have been hidden, all that we could say of the oxygen itself.

Again, the body of facts included in the theory of definite proportions, witnesses to the truth of the conservation of force; and though we know little of the cause of the change of properties of the acting and produced bodies, or how the forces of the former are hid amongst those of the latter, we do not for an instant doubt the conservation, but are moved to look for the manner in which the forces are, for the time, disposed, or if they have taken up another form of force, to search what that form may be.

Even chemical action at a distance, which is in such antithetical contrast

with the ordinary exertion of chemical affinity, since it can produce effects miles away from the particles on which they depend, and which are effectual only by forces acting at insensible distances, still proves the same thing, the conservation of force. Preparations can be made for a chemical action in the simple voltaic circuit, but until the circuit be complete that action does not occur; yet in completing we can so arrange the circuit, that a distant chemical action, the perfect equivalent of the dominant chemical action, shall be produced; and this result, whilst it establishes the electro-chemical equivalent of power, establishes the principle of the conservation of force also, and at the same time suggests many collateral inquiries which have yet to be made and answered, before all that concerns the conservation in this case can be understood.

This and other instances of chemical action at a distance carry our inquiring thoughts on from the facts to the physical mode of the exertion of force; for the qualities which seem located and fixed to certain particles of matter appear at a distance in connection with particles altogether different. They also lead our thoughts to the *conversion* of one form of power into another; as, for instance, in the *heat* which the elements of a voltaic pile may either show at the place where they act by their combustion or combination together, or in the distance, where the electric spark may be rendered manifest; or in the wire of fluids of the different parts of the circuit.

When we occupy ourselves with the dual forms of power, electricity, and magnetism, we find great latitude of assumption, and necessarily so, for the powers become more and more complicated in their conditions. But still there is no apparent desire to let loose the force of the principle of conservation, even in those cases where the appearance and disappearance of force may seem most evident and striking. Electricity appears when there is consumption of no other force than that required for friction; we do not know how, but we search to know, not being willing to admit that the electric force can arise out of nothing. The two electricities are developed in equal proportions; and having appeared, we may dispose variously of the influence of one upon successive portions of the other, causing many changes in relation, yet never able to make the sum of the force of one kind in the least degree exceed or come short of the sum of the other. In that necessity of equality, we see another direct proof of the conservation of force, in the midst of a thousand changes that require to be developed in their principles before we can consider this part of science as even moderately known to us.

One assumption with regard to electricity is, that there is an electric fluid rendered evident by excitement in plus and minus proportions. Another assumption is, that there are two fluids of electricity, each particle of each repelling all particles like itself, and attracting all particles of the other kind always, and with a force proportionate to the inverse square of the distance, being so far analogous to the definition of gravity. This hypothesis is antagonistic to the law of the conservation of force, and open to all the objections that have been, or may be, made against the ordinary definition of gravity. Another assumption is, that each particle of the two electricities has a

given amount of power, and can only attract contrary particles with the sum of that amount, acting upon each of two with only half the power it could in like circumstances exert upon one. But various as are the assumptions, the conservation of force (though wanting in the second) is, I think, intended to be included in all. I might repeat the same observations nearly in regard to magnetism — whether it be assumed as a fluid, or two fluids or electric currents — whether the external action be supposed to be action at a distance, or dependent on an external condition and lines of force — still, all are intended to admit the conservation of power as a principle to which the phenomena are subject.

The principles of physical knowledge are now so far developed as to enable us not merely to define or describe the *known*, but to state reasonable expectations regarding the *unknown;* and I think the principle of the conservation of force may greatly aid experimental philosophers in that duty to science, which consists in the enunciation of problems to be solved. It will lead us, in any case where the force remaining unchanged in form is altered in direction only, to look for the new disposition of the force; as in the cases of magnetism, static electricity, and perhaps gravity, and to ascertain that as a whole it remains unchanged in amount — or, if the original force disappear, either altogether or in part, it will lead us to look for the new condition or form of force which should result, and to develop its equivalency to the force that has disappeared. Likewise, when force is developed, it will cause us to consider the previously existing equivalent to the force so appearing; and many such cases there are in chemical action. When force disappears, as in the electric or magnetic induction after more or less discharge, or that of gravity with an increasing distance, it will suggest a research as to whether the equivalent change is one within the apparently acting bodies, or one *external* (in part) to them. It will also raise up inquiry as to the nature of the internal or external state, both before the change and after. If supposed to be external, it will suggest the necessity of a physical process, by which the power is communicated from body to body; and in the case of external action, will lead to the inquiry whether, in any case, there can be truly action at a distance, or whether the ether, or some other medium, is not necessarily present.

We are not permitted as yet to see the nature of the source of physical power, but we are allowed to see much of the consistency existing amongst the various forms in which it is presented to us. Thus, if, in static electricity, we consider an act of induction, we can perceive the consistency of all other like acts of induction with it. If we then take an electric current, and compare it with this inductive effect, we see their relation and consistency. In the same manner we have arrived at a knowledge of the consistency of magnetism with electricity, and also of chemical action and of heat with all the former; and if we see not the consistency between gravitation with any of these forms of force, I am strongly of the mind that it is because of our ignorance only. How imperfect would our idea of an electric current now be, if we were to leave out of sight its origin, its static and dynamic induction, its magnetic influence, its chemical and heating effects; or our idea of

any one of these results if we left any of the others unregarded? That there should be a power of gravitation existing by itself, having *no relation to the other natural powers, and no respect to the law of the conservation of force,* is as little likely as that there should be a principle of levity as well as of gravity. Gravity may be only the residual part of the other forces of nature, as Mossiti has tried to show; but that it should fall out from the law of all other force, and should be outside the reach either of further experiment or philosophical conclusions, is not probable. So we must strive to learn more of this outstanding power, and endeavor to avoid any definition of it which is incompatible with the principles of force generally, for all the phenomena of nature lead us to believe that the great and governing law is one. I would much rather incline to believe that bodies affecting each other by gravitation act by lines of force of definite amount (somewhat in the manner of magnetic or electric induction, though with polarity), or by an ether pervading all parts of space, than admit that the conservation of force could be dispensed with.

It may be supposed, that one who has little or no mathematical knowledge should hardly assume a right to judge of the generality and force of a principle such as that which forms the subject of these remarks. My apology is this: I do not perceive that a mathematical mind, simply as such, has any advantage over an equally acute mind not mathematical, in perceiving the nature and power of a natural principle of action. It cannot of itself introduce the knowledge of any new principle. Dealing with any and every amount of static electricity, the mathematical mind has balanced and adjusted them with wonderful advantage, and has foretold results which the experimentalist can do no more than verify. But it could not discover dynamic-electricity, nor electro-magnetism, nor magneto-electricity, or even suggest them; though when once discovered by the experimentalist, it can take them up with extreme facility.

So in respect of the force of gravitation, it has calculated the results of the power in such a wonderful manner as to trace the known planets through their courses and perturbations, and in so doing has *discovered* a planet before unknown; but there may be results of the gravitating force of other kinds than attraction inversely as the square of the distance, of which it knows nothing, can discover nothing, and can neither assert nor deny their possibility or occurrence. Under these circumstances, a principle which may be accepted as equally strict with mathematical knowledge, comprehensible without it, applicable by all in their philosophical logic, whatever form that may take, and above all, suggestive, encouraging, and instructive to the mind of the experimentalist, should be the more earnestly employed and the more frequently resorted to when we are laboring either to discover new regions of science, or to map out and develop those which are known into one harmonious whole; and if in such strivings, we, whilst applying the principle of conservation, see but imperfectly, still we should endeavor to see, for even an obscure and distorted vision is better than none. Let us, if we can, discover a new thing in *any shape;* the true appearance and character will be easily developed afterwards.

Some are much surprised that I should, as they think, venture to oppose the conclusions of Newton; but here there is a mistake. I do not oppose Newton on any point; it is rather those who sustain the idea of action at a distance, that contradict him. Doubtful as I ought to be of myself, I am certainly very glad to feel that my convictions are in accordance with his conclusions. At the same time, those who occupy themselves with such matters ought not to depend altogether upon authority, but should find reason within themselves, after careful thought and consideration, to use and abide by their own judgment. Newton himself, whilst referring to those who were judging his views, speaks of such as are competent to form an opinion in such matters, and makes a strong distinction between them and those who were incompetent for the case.

But after all, the principle of the conservation of force may by some be denied. Well, then, if it be unfounded even in its application to the smallest part of the science of force, the proof must be within our reach, for all physical science is so. In that case, discoveries as large or larger than any yet made, may be anticipated. I do not resist the search for them, for no one can do harm, but only good, who works with an earnest and truthful spirit in such a direction. But let us not admit the destruction or creation of force without clear and constant proof. Just as the chemist owes all the perfection of his science to his dependence on the certainty of gravitation applied by the balance, so may the physical philosopher expect to find the greatest security and the utmost aid in the principle of the conservation of force. All that we have that is good and safe, as the steam-engine, the electric-telegraph, &c., witness to that principle, — it would require a perpetual motion, a fire without heat, heat without a source, action without reaction, cause with effect, or effect without a cause, to displace it from its rank as a law of nature.

MONOGENESIS OF FORCE.

A lecture which has attracted considerable attention has been delivered before the Royal Institution London during the past year, by Mr. Alfred Smee, on the "Monogenesis of the Physical Forces." The conclusion to which Mr. Smee arrives is, that "attraction acting on attracted matter is the source of all force, and that, therefore, every physical force has a monogenetic orgin, and when generated, a truly equivalent power."

DENSITY OF THE EARTH.

The experiments of the English Astronomers in the Harton Coal Pit, according to Rev. S. Haughton, (Phil. Mag. [4], xii. 50), give for the mean density of the earth, 5·480. The pit was 1260 feet deep, and the seconds pendulum gained two and a quarter seconds per day at the bottom of the coal pit.

But the calculations of Mr. Airy, the Astronomer Royal (ib. p. 231) as given in the same journal vol. xii. p. 231, arrive at 6·566 as the mean density, which number at page 468 is changed to 6·809 — 6·623, the variation depending on the relative value of some of the observations.

FIGURE OF THE EARTH AND THE TIDES.

The results of the Ordnance Survey of Great Britain, so far as they relate to the earth's figure and mean density, have been lately laid before the Royal Society by Col. James, the Superintendent of the Survey. The ellipticity deduced is $\frac{1}{299 \cdot 33}$. The mean specific gravity of the earth, as obtained from the attraction of Arthur's Seat, near Edinburgh, is 5·316; a result which accords satisfactorily with the mean of the results obtained by the torson balance. Of the accuracy of this important work, it is sufficient to observe, that when the length of each of the measured bases (in Salisbury Plain and on the shores of Lough Foyle) was computed from the other, through the whole series of intermediate triangles, the difference from the measured length was only five inches in a length of from five to seven miles. Our knowledge of the laws of the *Tides* has received an important accession in the results of the tidal observations made around the Irish coasts in 1851, under the direction of the Royal Irish Academy. The discussion of these observations was undertaken by Professor Haughton, and that portion of it which relates to the diurnal tides has been already completed and published. The most important result of this duscussion, is the separation of the effects of the sun and moon in the diurnal tide — a problem which was proposed by the Academy as one of the objects to be attained by the contemplated observations, and which has been now for the first time accomplished.

From the comparison of these effects, Professor Haughton has drawn some remarkable conclusions relative to the mean depth of the sea in the Atlantic. In the dynamical theory of the tides, the ratio of the solar to the lunar effect depends not only on the masses, distances, and periodic times, of the two luminaries, but also on the depth of the sea, and this, accordingly, may be computed when the other quantities are known. In this manner, Professor Haughton has deduced from the solar and lunar co-efficients of the diurnal tide a mean depth of 5·12 miles — a result which accords in a remarkable manner with that inferred from the ratio of the semi-diurnal co-efficients, as obtained by Laplace from the Best observations. The subject, however, is far from being exhausted. The depth of the sea, deduced from the solar and lunar *tidal intervals,* and from *the age* of the lunar diurnal tide, is somewhat more than double of the foregoing; and the consistency of the individual results in such as to indicate that their wide difference from the former is not attributable to errors of observation. Professor Haughton throws out the conjecture that the depth, deduced from the tidal *intervals* and *ages,* corresponds to a different part of the ocean from that inferred from the *heights.* — *Address of the President British Association,* 1857.

SECULAR VARIATIONS IN LUNAR AND TERRESTRIAL MOTION FROM THE INFLUENCE OF TIDAL ACTION.

The following paper by Mr. D. Vaughan of Cincinnati, was read before the British Association for 1857.

Laplace concludes from his elaborate investigations, that the rotation of

the earth is not affected by the occurrence of the tides; nor do his formulæ reveal any permanent alteration in the motion of the lunar orb which disturbs the repose of our oceans. These results, announced by so high an authority, might be received without a careful examination if the fundamental principles of natural philosophy did not discountenance the idea of an actual creation of power by lunar attraction. The tides constitute an important mechanical agent; and, could their whole force be rendered available, it would be found adequate to several hundred times the labor of the human population. So great an amount of motive power, whether appropriated to the great purposes of nature and art, or wasted in overcoming friction, cannot be produced without some expense; and my present object is to trace the change which it involves in the motions of the earth and the moon. As the extreme disproportion between the momentum of the oceanic waters and that of the planetary bodies is the chief source of error in these investigations, I shall commence by showing how the tidal action should operate, if the moon moved around the earth in an exact circle, situated in the plane of the equator, and not more than 34,000 miles in diameter. Her periodical revolution, in this case, would occupy nearly twelve hours, and the lumar day would be about twenty-four hours in length. The tidal action on the seas nearest to the moon would be almost twice as great as on those most distant; the former being about 5,000 times, and the latter over 2,500 times, the disturbing action now exerted by the moon on the watery domain. The aqueous appendage of our planet would, in this case, form two great movable oceans, sustained on its opposite sides by the attraction of our satellite, and keeping pace with her movements. Without taking into consideration oscillations of the solid part of the earth which might possibly occur in these circumstances, it is evident that there should be a general flow of the waters from west to east; and though the current may be alternately reversed in deep channels, the force propelling it in an eastern direction should always maintain the ascendency. A vast body of water, circulating around the earth from west to east, could not fail to accelerate its rotary motion; although the result would not be exhibited by the formulæ of Laplace. The moon, in this case, would sustain a loss of momentum to a more considerable extent. It is well known that the attraction of mountains modifies the direction of terrestrial gravity in their vicinity; and that a plumb-line on that part of the equator immediately west of the Andes would be slightly deflected to the east. In the case we have supposed, the direction of terrestrial gravity would experience a similar deflexion at places in conjunction with the moon from the attraction of the excess of waters which swelled behind her. Accordingly, the lunar orb would be drawn, not directly to the earth's centre, but always to a point a little westward of it, and a constant loss of motion would be an inevitable consequence. It would be different if the earth could preserve an invariable form, for in that case its attraction on a satellite being always directed to the centre, or alternately deflected east and west of that point, the loss and gain of motion should be evenly balanced after one or many revolutions. Other investigations lead to the same conclusion. A satellite revolving just beyond the confines of our atmosphere,

would alternately accelerate and retard the movements of one more distant; and physical astronomy shows, that, in our planetary systems a like periodicity results from the inequality of the times in which the several planets perform their revolutions. But, as the tide-wave rolls around the earth with the same mean angular velocity as the moon, their mutual action will not exhibit the periodicity which characterizes planetary disturbances. In the analytical solution of this problem, the equation depending on the difference of motion of the moon and the tide-wave would acquire by integration a divisor infinitely small; and this proves its secular character. If Laplace finds no such divisors, it is because all the modifications in the action of the moon on the waters of the ocean are not embraced in his investigations on the subject. Leaving the supposed case, we shall now pass to the actual condition of the agencies concerned in tidal phenomena on our globe. At her present distance the revolution of the moon occupies more time than the earth's period of rotation; and the tidal wave which has the greatest disturbing influence being always east of our satellite, must add to its velocity, while it retards that of the earth. We may remark, however, that the additional velocity imparted to the moon would give her a larger orbit, and increase the period of her revolution. Hence the orbital motion of the moon, as well as the rotary motion of the earth, sustain a loss depending on the difference of the tidal force on opposite sides of our globe, and so very insignificant, that some millions of years would be required to cause a reduction of one per cent, in the momenta of these vast bodies. I must, however, question the results of Laplace, who finds that the change in the length of the day has not amounted to the one hundredth part of a second during the last 2,000 years. This conclusion is based on a comparison of ancient and modern eclipses; and the time of the earth's rotation is thus ascertained from the revolutions of the moon, making corrections for the disturbances operating on the latter body. But all the disturbing influences have not been yet taken into consideration; and as the one noticed in the present article operates on the earth and moon, we cannot regard either of these bodies as an infallible chronometer for measuring the vast ages of eternity.

ON THE DIRECTION OF GRAVITY ON THE EARTH'S SURFACE.

Professor Hennessy, in a paper before the British Association, Dublin, stated that for all practical purposes the direction of gravity was considered perpendicular to the earth's surface, and a similar assumption was often made in writings claiming a high degree of scientific accuracy. This arose from defining the earth's surface as the surface of equilibrium of the waters. If the earth were stripped of its fluid covering, the irregular surface so laid bare would present considerable inequalities. From what is now known regarding the depth of the ocean, the continents would appear as plateaus elevated above the oceanic depressions to an amount which, although small compared to the earth's radius, would be considerable when compared to its outswelling at the equator, and its flattening towards the poles. The surface thus presented would be the true surface of the earth, and would not be

perpendicular to gravity. If a kind of mean surface be conceived intersecting this, so as to leave equal volumes above of elevations, and of depressions below it, it is not allowable to assume that such a surface is perpendicular to gravity. The mean surface of the solid crust of the earth would not be perpendicular to gravity, if, after the process of solidification had commenced, any extensive changes in the distribution of matter in the earth's interior could take place. If the fluid matter in solidifying underwent no change of volume, the forms of the strata of equal density within the earth would be the same at every stage of its solidification. But if, as observation indicates, such fused matter, on passing to the solid crystalline state, should diminish in volume, the pressure on the remaining strata of the fluid would be relieved, and they would tend to assume a greater ellipticity than they had when existing under a greater pressure. The general result of this action would manifestly be to produce a change in the direction of the attractive forces at the outer surface of the solid crust. The direction of a plumb-line would be slightly altered so as to slightly increase the apparent latitudes of places over a zone intermediate between the equator and poles. — M. D'Abbadie stated several cases which he had met with, where monuments existed which showed that the direction of gravity, at some former period, must have been very different in relation to those particular portions of the earth from what it now was.— Other Members also noticed deviations of the plumb-line from its normal position, and some of them which seemed to depend on the season of the year.— The President, Dr. Robinson, stated that he was the first to direct attention to those changes of level which depended on the season of the year. This he was led to observe from the fact that the entire mass of rock and hill on which the Armagh Observatory was erected was found to be slightly, but to an astronomer quite perceptibly, tilted or canted at one season to the east, at another, to the west. This he had at first attributed to the varying power of the sun's radiation to heat and expand the rock throughout the year; but he since had reason to attribute it rather to the infiltration of water to the parts where the clay, slate, and limestone rock met in their geological arrangement. The varying quantity of this through the year he now believed exercised a powerful hydrostatic energia, by which the position of the rock was slightly varied.

ON THE RECENT DISCOVERIES RELATIVE TO HEAT.

In the whole range of experimental science there is no fact more familiar, or longer known, than the development of *Heat* by friction. The most ignorant savage is acquainted with it, — it was probably known to the first generation of mankind. Yet, familiar as it is, the science of which it is the germ dates back but a very few years. It was known from the time of Black, that heat disappeared in producing certain changes of state in bodies, and re-appeared when the order of those changes was reversed; and that the amount of heat, thus converted, had a given relation to the effect produced. In one of these changes — namely, evaporation — a definite mechanical force is developed, which is again absorbed when the vapor is restored by pressure to the liquid state. It was, therefore, not unnatural to conjecture, that in all

cases in which heat is developed by mechanical action, or *vice versâ*, a definite relation would be found to subsist between the amount of the action and that of the heat developed or absorbed. This conjecture was put to the test of experiment by Mayer and Joule, in 1842, and was verified by the result. It was found that *heat* and *mechanical power* were *mutually convertible;* and that the relation between them was *definite,* 772 *foot-pounds* of motive power being equivalent to a *unit of heat* — that is, to the amount of heat requisite to raise a pound of water through one degree of Fahrenheit. The science of Thermodynamics, based upon this fact, and upon a few other obvious facts or self-evident principles, has grown up in the hands of Clausius, Thomson, and Rankine, into large proportions, and is each day making fresh conquests from the region of the unknown. Thus far the science of heat is made to rest wholly upon the facts of experiment, and is independent of any hypothesis respecting the molecular constitution of bodies. The dynamical theory of heat, however, has materially aided in establishing true physical conceptions of the *nature of heat.* The old hypothesis of caloric, as a separate substance, was indeed rendered improbable by the experiments of Rumford and Davy, and by the reasonings of Young; but it continued to hold its ground, and is interwoven into the *language* of science. It is now clearly shown to be self-contradictory; and to lead to the result that the amount of heat in the universe may be indefinitely augmented. On the other hand, the identification of radiant heat with light, and the establishment of the wave-theory, left little doubt that heat consisted in a *vibratory movement* either of the molecules of bodies or of the ether within them. Still, the relation of heat to bodies, and the phenomena of conduction, indicate a mechanism of a more complicated kind than that of light, and leave ample room for further speculation. The only mechanical hypothesis (so far as I am aware) which is consistent with the present state of our knowledge of the phenomena of heat, is the theory of *molecular vortices* of Mr. Rankine. In this theory all bodies are supposed to consist of *atoms,* composed of *nuclei* surrounded with *elastic atmospheres.* The radiation of light and heat is ascribed to the transmission of oscillations of the nuclei; while *thermometric heat* is supposed to consist in circulating currents or *vortices,* amongst the particles of their atmospheres, whereby they tend to recede from the nuclei, and to occupy a greater space. From this hypothesis Mr. Rankine has deduced all the laws of thermo-dynamics, by the application of known mechanical principles. He has also, from the same principles, deduced relations (which have been confirmed by experiment) between the pressure, density and absolute temperature of elastic fluids, and between the pressure and temperature of ebullition of liquids. The dynamical theory of heat enables us to frame some conjectures to account for the continuance of its supply, and even to speculate as to its source. The heat of the sun is dissipated and lost by radiation; and must be progressively diminished unless its thermal energy be supplied. According to the measurements of M. Pouillet, the quantity of heat given out by the sun in a year is equal to that which would be produced by the combustion of a stratum of coal seventeen miles in thickness; and if the sun's capacity for heat be assumed equal

to that of water, and the heat be supposed to be drawn uniformly from its entire mass, its temperature would thereby undergo a diminution of 2° 4· Fahr. annually. On the other hand, there is a vast store of force in our system capable of conversion into heat. If, as is indicated by the small density of the sun, and by other circumstances, that body has not yet reached the condition of incompressibility, we have, in the future approximation of its parts, a fund of heat probably quite large enough to supply the wants of the human family to the end of its sojourn here. It has been calculated that an amount of condensation, which would diminish the diameter of the sun by only the ten-thousandth part, would suffice to restore the heat emitted in 2000 years. Again, on our own earth, *vis viva* is destroyed by friction in the ebb and flow of every tide, and must therefore re-appear *as heat*. The amount of this must be considerable, and should not be overlooked in any estimation of the physical changes of our globe. According to the computation of Bessel, 25,000 cubic miles of water flow in every six hours from one quarter of the earth to another. The store of mechanical force is thus diminished, and the temperature of our globe augmented by every tide. We do not possess the data which would enable us to calculate the magnitude of these effects. All that we know with certainty is, that the *resultant effect* of all the thermal agencies to which the earth is exposed has undergone no perceptible change with the historic period. We owe this fine deduction to Arago. In order that the *date palm* should ripen its fruit, the mean temperature of the place must exceed 70° Fahr.; and, on the other hand, the *vine* cannot by cultivated successfully when the temperature is 72° or upwards. Hence, the mean temperature of any place at which these two plants flourished and bore fruit must lie between these narrow limits, *i. e.* could not differ from 71° Fahr. by more than a single degree. Now, from the Bible we learn that both plants were *simultaneously* cultivated in the central valleys of Palestine in the time of Moses; and its then temperature is thus definitely determined. It is the same at the present time; so that the mean temperature of this portion of the globe has not sensibly altered in the course of thirty-three centuries.

The future of physical science seems to lie in the path upon which three of the ablest British physicists have so boldly entered, and in which they have already made such large advances. I may, therefore, be permitted briefly to touch upon the successive steps in this lofty generalization, and to indicate the goal to which they tend. It has been long known, that many of the forces of nature are related. Thus, heat is produced by *mechanical action*, when that is applied in bringing the atoms of bodies nearer by compression, or when it is expended in friction. Heat is developed by *electricity*, when the free passage of the latter is impeded. It is produced whenever *light is absorbed*; and it is generated by *chemical action*. A like interchangeability probably exists among all the other forces of nature, although in many the relations have not been so long perceived. Thus, the development of electricity from chemical action dates from the observations of Galvani; and the production of magnetism by electricity from the discovery of Oersted. The next great step was to perceive that the relation of the physical forces

was *mutual;* and that of any two, compared together, either may stand to the other in the relation of *cause.* With respect to heat and mechanical force, this has been long known. When a body is *compressed* by mechanical force, it gives out *heat;* and, on the other hand, when it is *heated,* it dilates, and evolves *power.* The knowledge of the action of electricity in dissolving the bonds of chemical union followed closely upon that of the inverse phenomenon; and the discovery of *electro-magnetism* by Oersted was soon followed by that of *magneto-electricity* by Faraday. With reason, therefore, it occurred to many minds that the relations of any two of the forces of nature were *mutual* — that that which is the *cause,* in one mode of interaction, may become the *effect,* when the order of the phenomena is changed; — and that, therefore, in the words of Mr. Grove, one of the able expounders of these views, while they are "correlative," or reciprocally dependent, "neither, taken abstractly, can be said to be the essential cause of the others." But a further step remained to be taken. If these forces were not only related, but mutually related, was it not probable that the relation was also a *definite* one? Thus, when heat is developed by mechanical action, ought we not to expect a certain definite proportion to subsist between the interacting forces, so that if one were doubled or trebled in amount, the other should undergo a proportionate change? This anticipation, it has been already stated, has been realized by Mayer and Joule. The discovery of the mechanical equivalent of heat has been rapidly followed by that of other forces; and we now know, not only that electricity, magnetism, and chemical action, in given quantities, will produce each a *definite amount of mechanical work,* but we know further — chiefly through the labors of Mr. Joule — what that relation is, or, in other words, *the mechanical equivalent of each force.* The first step in this important career of discovery — though long unperceived in its relation to the rest — was, undoubtedly, Faraday's great discovery of the definite chemical effect of the voltaic current. The last will probably be to reduce all these phenomena to *modes of motion,* and to apply to them the known principles of dynamics, in such a way as not only to express the laws of each kind of movement, as it is in itself, and also the connection and dependence of the different classes of the phenomena.

A bold attempt at such a generalization has been made by M. Helmholtz. The science of Thermodynamics starts from the principle, that *perpetual motion is impossible,* or, in other words, that we cannot, by any combination of natural bodies, produce force out of nothing. In mechanical force, this principle is reducible to the known law of the *conservation of vis viva;* and M. Helmholtz has accordingly endeavored to show that this law is maintained in the interaction of all the natural forces; while, at the same time, the assumption of its truth leads to some new consequences in physics, not yet experimentally confirmed. Expressed in its most general form, this principle asserts that the *gain* of *vis viva* during the motion of a system, is equal to the *force consumed* in producing it; from which it follows, that the sum of the *vires vivæ,* and of the existing forces, is constant. This principle M. Helmholtz denominates the *conservation of force.* A very important consequence of its establishment must be, that all the actions of nature are

due to attractive and repulsive forces, whose intensity is a function of the distance — the conservation of *vis viva* holding only for such forces. It is usually stated, in mechanical works, that there is a *loss* of *vis viva* in the *collision of inelastic bodies,* and in *friction.* This is true with respect to the *motion of masses,* which forms the subject of mechanical science as at present limited; but it is not true in a larger sense. In these, and such-like cases, the movement of masses is transformed into *molecular motion,* and thus re-appears as heat, electricity, and chemical action; and the amount of the transformed action definitely corresponds to the mechanical force which was apparently lost. In the cases just considered, mechanical action is converted into molecular. But molecular actions of different kinds are themselves, in like manner, interchangeable. Thus, when *light* is absorbed, *vis viva* is apparently lost; but — not to speak of *phosphorescence,* in which the light absorbed, or a portion of it, is again given out — in all such cases heat and chemical action are developed, and in amount corresponding to the loss. Hence the apparent exceptions to the principle are in reality confirmations of it; and we learn that the quantity of force in nature is as unchangeable as the quantity of matter. This, however, is not true of the quantity of *available force.* It follows from Carnot's law, that heat can be converted in mechanical work only when it passes from a warmer to a colder body. But the radiation and conduction by which this is effected tend to bring about an *equilibrium of temperature,* and therefore to annihilate mechanical force: and the same destruction of energy is going forward in the other processes of nature. Thus, it follows from the law of Carnot, as Prof. Thomson has shown, that the universe tends to a state of eternal rest; and that its store of available force must be at length exhausted. Mr. Rankine has attempted, in another method, to combine the physical sciences into one system, by distinguishing the properties which the various classes of physical phenomena possess in common, and by taking for axioms propositions which comprehend their laws. The principles thus obtained are applicable to all physical change; and they possess all the certainty of the facts from which they are derived by induction. The subject matter of the science so constituted is *energy,* or the capacity to effect changes; and its fundamental principles are, first, that all kinds of energy and work are homogeneous — or in other words, that any kind of energy may be made the means of performing any kind of work; and, secondly, that the total energy of a substance cannot be altered by the mutual action of its parts. From these principles the author has deduced some very general laws of the *transformation of energy,* which include the known relations of physical forces.— *Dr. Loyd's Address before the British Association,* 1857.

ON THE DEVELOPMENT OF HEAT IN AGITATED WATER.

Mr. G. Rennie, in a communication to the British Association on the above subject, stated that the subject of the mechanical or dynamic force required to raise a given quantitity of water one degree of Fahrenheit had long been the object of the research of philosophers, ever since Count Rumford, in his celebrated experiments on the evolution of heat in boring guns

when surrounded by ice or water, proved the power required to raise one pound of water one degree, and which he valued at the dynamic equivalent of 1,034 lbs. M. Moya was the first who announced that heat was evolved from agitated water. The second was Mr. Joule, who announced that heat was evolved by water passing through narrow tubes, and by this method each degree of heat required for its evolution a mechanical force of 770 lbs. Subsequently, in 1845 and 1847 he arrived at a dynamical equivalent of 772 lbs. These experiments had since been confirmed by other philosophers on the Continent. In the present paper, Mr. Rennie stated that his attention was called to the subject by observing the evolution of heat by the sea in a storm, by the heat from water running in sluices. He, therefore, prepared an apparatus similar to a patent churn, somewhat similar to that adopted by Mr. Joule, but on a large scale. In the first case, he experimented on fifty gallons, or 500 lbs. of water, inclosed in a cubical box, and driven by a steam engine instead of a weight falling from a given height, as in Mr. Joule's experiment; secondly, on a smaller scale, by 10 lbs. of water inclosed in a box. The large machine or churn was driven at a slow velocity of eighty-eight evolutions per minute, and the smaller machine at the rate of 232 evolutions per minute, so that the heat given off by the water in the large box was only at the rate of three and a half degrees per hour, including the heat lost by radiation; whereas the heat evolved by the ten gallons of water contained in the small box agitated at 232 evolutions was fifty-six degrees Fahrenheit per hour. Thus the temperature of the water in the large box was raised from sixty degrees to 144 degrees, and the temperature of the water in the small box to boiling point. As an illustration, an egg was boiled hard in six minutes. The mechanical equivalent, in the first case, was found to approximate nearly to that of Mr. Joule, but in the latter case it was considerably above his equivalent, arising, very probably, from the difficulty of measuring accurately the retarding forces.

PRELIMINARY RESEARCHES ON THE ALLEGED INFLUENCE OF SOLAR LIGHT ON THE PROCESS OF COMBUSTION.

The following is an abstract of a paper read before the American Association for the promotion of Science, on the above subject, by Prof. J. L. Conte.

A popular opinion has long prevailed in England, and perhaps in other countries, that the admission of the light of the sun to an ordinary fire tends to *retard* the process of combustion. In some instances, the practice of placing screens before the fireplace, or of closing the shutters of the apartment, may be traced to the prevalent belief, that the access of sunlight to the burning materials is unfavorable to the continuance of the phenomenon of combustion. Most physical philosophers very naturally regard this opinion as a mere *popular prejudice;* probably originating in the well-known apparent dulling or obscuration of flames and of solid bodies in a state of ignition,—which takes place when they are exposed to strong light. The flame of a jet of burning hydrogen is scarcely visible in the diffused light of a clear day; that of an ordinary alcohol lamp is barely appreciable to the

eye when exposed to the direct sunshine; while a portion of ignited charcoal, which glows in the dark, appears to be extinguished when placed in the sunlight. These familiar phenomena, attributable to well-established physico-physiological laws, seem to afford a much more rational explanation of the origin of the popular opinion, than to suppose it to be based upon accurate observations relating to the actual rapidity of burning.

In the year 1825, Dr. Thomas McKeever, of England, published a series of experiments in the *Annals of Philosophy*, which seemed to show that there is a real foundation for the popular opinion, and that solar light does actually retard the process of combustion. These results were copied by the contemporary scientific journals, and were considered as proving beyond a doubt, that what had previously been esteemed a "vulgar error," was, in reality, an instinctive popular induction, based upon experience and observation. Even Gmelin, in his *Hand Book of Chemistry*, announces Dr. McKeever's conclusions, without expressing any misgivings in relation to their accuracy.

The important bearing which these results seem to have on the influence of solar light on chemical processes, as well as on certain modern theories, induced Professor Le Conte, during the months of May and June last, to undertake a series of experiments with the view of testing the validity of Dr. McKeever's conclusions. In order to understand what follows, it is necessary to state that Dr. McKeever made his experiments by determining the rate of burning of tapers and candles, when the combustion took place alternately in a darkened room, and in the sunshine in the open air. In every case he found the combustion was more rapid in the dark than in the sunshine; the excess in the former varying from five to eleven per cent. He supposes this effect to be owing to the well-known influence of the solar rays on many chemical processes;—in some instances accelerating them, but in others retarding them. Under this point of view, the *chemical rays* may be supposed to exercise a *deoxidizing* power, which, to some extent, interferes with the rapid oxidation of the combustible matter. In confirmation of this opinion, Dr. McKeever made an experiment which appears to indicate that a taper burns more rapidly in the *red* than in the *violet* extremity of the solar spectrum.

In attempting a repetition of these experiments, Professor Le Conte found it impossible to secure that freedom from agitation in the atmosphere which the investigation demanded, so long as he pursued Dr. McKeever's plan of exposing the burning body to the sunshine in the open air. There were, likewise, other considerations which urged him to modify the method of investigation; and among others, it occurred to him, that, as in Dr. McKeever's experiments, the temperature of the air which supplied oxygen for combustion in the sunshine, was about 12° above that in the darkened room, the rarefaction produced by heat might exercise some influence in retarding the rate of burning in the sunlight. He also desired to exaggerate the supposed influence, by using a concentrated pencil of solar light instead of ordinary sunshine.

In conducting his experiments Prof. Le Conte endeavored to secure two conditions, viz:

1. Absolute calmness in the atmosphere.

2. Exposure of the flame to the influence of intense solar light, without heating the surrounding air.

The first condition was secured by performing all of the experiments in a large lecture room, with all of the doors and windows closed. To secure the second condition, he employed a portion of the apparatus belonging to a large solar microscope, consising of the reflecting mirror, the condensing lens and tube, together with the mechanical arrangements for adjusting the direction of the light. As the condensing lens was upwards of four inches in diameter, the intensity of the light could be increased nearly tenfold : so that its effects ought to be enormously exaggerated. This arrangement cut off all of the influence of exterior agitations of the atmosphere; while the concentrated pencil of light, thus thrown on the flame, traversed it, as well as the surrounding air, without imparting a sensible amount of heat to the latter.

In his experiments, Prof. Le Conte used the best wax-candles. By allowing them to burn a sufficient length of time to form a well-defined cup for the melted wax, and carefully turning the wicks so as to render them self-snuffing, the combustion was found to go on with remarkable uniformity in a calm atmosphere. The *rate of burning* was determined in the following manner :—A portion of candle, three or four inches in length, was secured to the bottom of one of the scale pans of a tall balance and ignited; after allowing it to burn for ten or fifteen minutes, so as to secure a steady flame of constant size, it was *nearly* balanced by added weights to the opposite scale-pan, allowing a slight preponderance to the candle-pan. In a short time the equilibrium was established by the burning of the candle; the precise *time* at which the balance indicated a condition of equilibrium was *accurately noted.* Next, *a given* weight, (say sixty or one hundred grains,) was withdrawn from the weight-pan, and the *time* of restoring the equilibrium by the loss of weight in the burning candle, was, in like manner, recorded. In this manner, the rate of combustion was determined by observing the *time* occupied in consuming a *given weight* of the burning matter. The arrangements described above, enabled him to perform such experiments alternately in the darkened room, and in the concentrated sunbeam, *without moving* any portion of the apparatus in the room, and under external conditions as nearly identical as could be desired. Many preliminary experinents were made for the purpose of testing the delicacy of the arrangements, which very soon showed that no reliable results could be obtained unless the air was calm, and *also,* unless the candle was allowed to burn a *sufficient length of time* to establish *regularity* in the process of combustion. The days selected for the experiments, were perfectly *cloudless.* The state of the barometer and thermometer were carefully noted. The cone of sunlight was so direct, that its *lower* margin illuminated the charred portion of the wick of the candle, while the *upper* boundary of the pencil traversed the flame near its apex.

Under these circumstances, Prof. Le Conte found the rate of combustion to be sensibly the same in the dark and in the sunshine; the slight variations not exceeding the limits of experimeatal inaccuracies. These negative

results are considered more significant, from the fact that if light exercised the decided retarding influence on the rate of combustion which Dr. M'Keever's experiments seemed to indicate, we might reasonably anticipate a much more striking effect, when its intensity was increased tenfold by the action of a lens. Prof. Le Conte thinks that the results obtained by Dr. M'Keever were not produced by the influence of solar light, but by want of identity in the external conditions, and particularly by the higher temperature of the air which supplied the combustion in the sunshine, and the irregular agitations to which it was subjected in his mode of experimenting. Prof. Le Conte's own experiments afford striking illustration of the effects produced by comparatively slight alterations in the external conditions, on the rate of combustion. For, although he found the rate of burning to be the same in the dark and in the sunshine, on any given day, yet it varied from day to day, according to the barometric pressure and temperature of the air. This fact led him to investigate the probable effects of the three external conditions which may be supposed to influence the process of combustion. These are, *first*, barometric pressure; *second*, temperature of the air; and *third*, amount of aqueous vapor present.

1. Inasmuch as an increase or diminution of barometric pressure, *cæteris paribus*, necessarily augments or lessens the density of the air, and consequently influences the amount of oxygen contained in a given volume, we should *a priori* expect that it must exercise a corresponding effect on the rate of combustion. But we are not left to mere conjecture on this point. The experiments of Sir Humphry Davy prove that combustion is accelerated in condensed, while it is retarded in rarefied air. But the most striking and satisfactory experiment on the effects of condensed air in accelerating the process of burning, were those furnished incidentally, by M. Triger, a French Civil Engineer, in the year 1841, during the operations necessary for working a bed of coal underlying the alluvium bordering the river Loire, in the Department of Main-et-Loire. In traversing an overlying stratum of quicksand from fifty-nine to sixty-five and a half feet thick, he found it requisite to devise some means of excluding the semifluid quicksand and water, which found their way under every arrangement analogous to ordinary *cofferdams*, in such quantity as to defy all pumping operations intended to keep them dry. For this purpose, M. Triger employed large sheet-iron cylinders, about 3·39 feet in interior diameter, securely closed at the top, in which, — by means of a condensing pump incessantly worked by a steam-engine, — air was condensed to an amount sufficient to counteract the external hydrostatic pressure. The ingenious contrivance fully justified the expectations of the engineer; but the workmen were thus compelled to labor in air condensed under a pressure of about *three* atmospheres. Among other curious results of this state of things noticed by M. Triger, were the remarkable effects of condensed air on combustion. Much annoyance was at first experienced from the *rapid combustion* of the candles; which was only obviated by substituting flax for cotton threads in the wicks.

On the contrary, the observations of Mr. J. Mitchell, quartermaster of artillery of the English army, at Bangalore, in India, prove conclusively

that the "fuses of shells" burn more slowly at elevated stations, where the atmosphere is rarefied. At altitudes of 3,000, 6,500 and 7,300 feet, the rates of burning were found to be respectively 10, 20 and 27 per cent. slower than at the artillery dépôt. These facts seem to render it certain that any increase in the density of the air must accelerate combustion, while rarefaction must have an opposite effect.

It has long been a matter of common observation, that ordinary wood-fires burn more freely when the barometer is high; but, Mr. Marcus Bull and others maintain, that this result is not owing to the augmented *density* of the air, but to the greater *dryness* of the atmosphere. The facts brought forward in this paper, are strongly opposed to this explanation; for, there are not the slightest grounds for supposing, that there was *less* than the ordinary amount of aqueous vapor present in the condensing cylinders of M. Triger; or *more* than the usual quantity mixed with the air at the elevated stations in India. On the contrary, physical considerations lead us to precisely *opposite* conclusions.

2. In relation to the influence of the temperature of the air on the process of combustion, Professor Le Conte admitted that our information was very meagre. He showed that the experiments of Davy and others do not touch the question, inasmuch as they do not refer to the effect of temperature on the rate of burning. He contended, however, that so far as increase of temperature influences the density of the air, it is sufficiently evident, *cœteris paribus*, that its effect must be equivalent to a diminution of barometric pressure, and consequently, must tend to retard combustion. In like manner, assuming the temperature of the flame to be constant, it was shown that the draught created by it must be diminished in a warm atmosphere, and thereby tend to retard the rate of burning in hot weather. On the other hand, an augmentation of temperature might tend to accelerate the combustion by favoring the liquefaction of the wax, and facilitating the oxidation of the combustible matter. The last two effects were considered comparatively insignificant; and hence the conclusion was drawn, that the principal influence which temperature exercises on the rate of combustion is connected with its effects on the density of the air; and that, consequently, an increase of temperature should, *cœteris paribus*, retard the process.

3. In relation to the influence of the hygrometric condition of the air on combustion.

Sir Humphry Davy found that "a very large quantity" of *steam* was required to prevent sulphur from burning; that an explosive mixture of oxygen and hydrogen, when mixed with *five times its volume of steam*, still exploded by the electric spark; and that a mixture of air and carburetted hydrogen gas, required "a *third* of steam to prevent its explosion, whereas one fifth of azote produced the effect." Under any point of view, it is obvious, that the presence of aqueous vapor can only tend to *retard* the process of combustion. *First*, because it diminishes the amount of oxygen in a given volume of air, and *secondly*, because an admixture of any inactive gas tends to extinguish the burning body, as is abundantly proved by the experiments of Sir H. Davy and others. When vapor is present in large quantities,

there can be no doubt of its controlling agency on combustion. This is illustrated by the successful application of the plan proposed by M. Dujardin of Lille, in 1837, for extinguishing fires occurring in steam-ships, by permitting the steam from the boilers to escape into the apartment in which the combustion originates. But experiments are still wanting, for determining its influence on the rate of burning, when existing in the small quantities in which it is usually associated with the atmosphere. The experimental researches of Mr. David Waldie, in relation to the mixture of various gases with air, led him to the *general law*, that, " Of incombustible gases which remain undecomposed, the power of preventing combustion is in the order of their density; " and that, " This effect of density in cooling the flame depends on the excessive *diffusion* of the flame in the denser gas." Under ordinary circumstances, the *density* of the aqueous vapor existing in the air is comparatively *small*, so that, according to Mr. Waldie's law, its influence on combustion ought not to be very striking.

Having illustrated the influence of these three external conditions, Professor Le Conte next proceeded to investigate whether these were adequate to explain the variations in the rates of burning as indicated by observation. The observations requisite for testing the effects of aqueous vapor were wanting; but the effects of barometric pressure and temperature, were subjected to a quantitative test, on the assumption that the rapidity of combustion varies directly as the density of the air. By the application of a mathematical formula, he was enabled to apply this test to his own experiments." The ratios between the rates of combustion, were thus compared with the ratios between the corresponding densities of the air under different circumstances. The general result of this comparison was, that the variations in the density of the air are not adequate to explain the whole of the differences in the rates of burning; they explain the greater part of these differences, but there is a small per centage of excess in the rates of combustion, which he thinks attributable to the influence of aqueous vapor, and perhaps other causes not yet considered.

In the present stage of the investigation, Professor Le Conte thinks that two deductions are warranted. 1. That solar light does not seem to exercise any sensible influence on the process of combustion. 2. That variation in the density of the air does exercise a very decided influence on the rapidity of the process: the rate of burning increasing with every increment of density, and vice versa: but the exact ratio between them remains to be determined.

ON THE NATURE OF HEAT.

At the recent meeting of the German Association for the Promotion of Science, Baron Baumgartner discussed the alteration of some fundamental ideas concerning the nature of heat, which would probably take place in consequence of recent researches. About half a century ago, every series of similar phenomena was explained by the hypothesis of a special imponderable fluid. The undulatory theory of light led the way in the opposition to this materialistic tendency, and the development of the undulatory theory offers

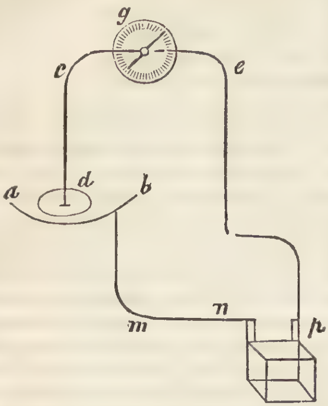
remarkable analogies with the progress of the Copernican system. The theory of heat has now arrived at the same stage as had the theory of light when Young made his appearance in the scientific world. Bacon's striking axiom, "What is heat for sensation is motion taken under an objective point of view;" with the results of Rumford and Davy, caused doubts as to the existence of a calorific matter; the precise exposition of a possible transmutation of moving into molecular force completely overthrew the old theory. Radiating heat, objectively identical to luminous rays, is the thermic phenomenon in its abstract form; luminous ether must therefore be considered the material substratum of these phenomena. The explanation of the phenomena of transmitted or conducted heat is connected with some more difficulties, but may be made more easy by the following considerations. A ray falling on a material medium is partly reflected; at the same time three different effects may take place — viz., *a*. the ray passes through the medium, without producing any change in it; *b*. the ether contained in the medium is set in motion, the body is heated, or, as it is (although improperly) said, "it absorbs heat;" (it is the absorbed heat which elevates the temperature of the body, and we use this expression, because a body endowed with sensitive faculty perceives the sensation of heat — a sensation determined generally, not by the quantity of motion, which constitutes the quantity of heat, but by the celerity of the particles passing through the position of rest;) *c*. the passage of the ray is attended by the excitation of heat. Caloric capacity is the faculty to receive a certain quantity of living power. Heat expands bodies, and this expansion is assumed as the measure of temperature. This effect, however, is not the immediate result of the oscillatory movement; a portion of it, proportional to the living power of the oscillation, is changed into operative power, which is the immediate consequence of expansion. This process may be still better understood by the action of an electric current running along a conducting wire, and converting itself into heat by contriving to overcome an obstacle. A similar process takes place with regard to caloric capacity whenever the volume of any body undergoes any change. A body has more capacity for heat (to use the still prevailing expression) whilst its volume is variable, than under a constant pressure, because a portion of the heat which it assumes is converted into operative power.

ON THE SPHEROIDAL STATE OF LIQUIDS.

With respect to the cause of the singular phenomena, known as the spheroidal state of liquids, differences of opinion still exist among men of science. The appearance of the drop on the heated surface suggests the idea that the liquid and metal are not in contact with each other; such a breach of contact, however, has been denied, and to determine this point, Poggendorff devised the following ingenious experiment: —

Let *a b* be a section of the basin, *d* that of the drop; into *d* let a platinum wire descend, which is united with the negative pole, *p*, of a small galvanic battery; a second platinum wire, *m n*, communicates with the positive pole of the battery, and is placed in contact with the metallic basin, *a b*. Into the

circuit thus formed is introduced a galvanometer, *g*, consisting of a magnetic needle, which swings freely within a coil of covered copper wire: the passage



of an electric current through the coil being, as is well known, rendered manifest by the deflection of the needle. Let the drop, *d*, be rendered a good conductor of electricity, by slightly acidulating it; if it were in contact with the basin, the circuit would at no place be interrupted; the current would pass without hindrance from *n* to the basin, thence through the drop to the platinum wire, *e*, and thence through the galvanometer to the other pole of the battery. In its passage it would deflect the needle of the galvanometer, and thus give evidence of its presence. It is, however, found that when the basin is heated, and the drop has assumed the spheroidal state, no current passes; and this certainly indicates the existence of an interval which interrupts the circuit between the basin and the drop. Let the lamp which heats the basin be now removed; after a time the drop sinks, comes into contact with the basin, and at that instant the needle of the galvanometer flies aside, thus demonstrating the passage of the current."

INFLUENCE OF TEMPERATURE ON CAPILLARY ATTRACTION.

The influence of temperature on capillarity, considered null by some authors, is still real. Lalande was the first to announce it, 1768; he showed that water did not stand as high when it was hot, or when the tube had been heated before making the experiment. Laplace and Poisson deduced from it that the height had some relation to the density of the liquid. Many eminent physicists have treated of this question, and from their results a wide divergence has been brought about between mathematical theory and experiment, and a complete separation of the phenomena of ascension and depression. All these questions have been taken up from their foundation and definitely resolved by the laborious researches of M. Wolf, Professor of Physics at the Lyceum of Strasburg, which have been continued through several years. The following are the facts arrived at: —

1. The elevation of the same liquid in capillary tubes depends, other things equal, on the nature of the tube.

2. In the same tube, at different temperatures, the height to which a liquid rises is in the compound proportion of the density and the curvature of the meniscus; this diminishes as the temperature increases, and becomes null at some specific temperature beyond which, the action is the reverse. The law of variation of pressure with the temperature for liquids which do not wet the glass, thus connects with the law of diminution of capillary eleva-

tion, and becomes a consequence of it. For if, at a given temperature, a liquid ceases to wet the glass, beyond this temperature the liquid takes a convex surface and depresses itself; whence it follows, that liquids like mercury not wetting the glass at the ordinary temperature, can wet it at a temperature quite low, and so present under the action of cold the same series of phenomena which either presents under that of heat.

ON THE HEAT-CONDUCTING POWER OF MERCURY.

At the recent meeting of the German Association for the promotion of science, Prof. Frankenheim read a paper "On the Heat-conducting Power of Mercury." The investigations of Fourier and Poisson determined the relation between the phenomena of conduction and those of radiation, the last made uniform by the use of varnishes. Mercury was enclosed in iron tubes, and thermometers, wrapped in thin membranes, plunged into them, the mobility of the mercury having been previously diminished by its amalgamation with small quantities of zinc. A constant temperature could be maintained only after a few hours' waiting. Prof. Frankenheim found that mercury ranked high among the best metallic conductors, both of heat and electricity. The theoretical views, founded on the lately prevailing supposition that liquid substances possess very little, if any, conductive power, rest on an erroneous argument, attaching excessive importance to the state of aggregation. According to Prof. Frankenheim's definition, elasticity in solid and in liquid bodies has this difference: that in the latter the particles may undergo rotation without giving rise to the manifestation of any force, while in the former, rotation and manifestation of force are essentially connected.

ON THE INFLUENCE OF METALS ON RADIANT HEAT.

The results of a recent investigation on this subject, by Prof. H. Knoblunch, of Halle, may be stated to be as follows:

1. Metals, as gold, silver, and platinum, when in thin layers, are to be regarded as diathermanous bodies, which permit a portion of the calorific rays to pass through them; which portion naturally becomes less as the thickness of the layer increases.

In thus transmitting the calorific rays, certain metals, as gold and silver, exercise an elective absorption, similar to that of colored transparent bodies upon light. Others, on the contrary, like platinum, act in the same manner upon all rays, and are therefore to be regarded as analogous to colorless bodies in the case of light.

2. In the case of diffuse reflection, also, certain metals, such as gold, silver, mercury, copper and brass, similar to colored and opaque bodies as regards light, exercise an elective absorption upon the calorific rays, in consequence of which the properties of the latter are altered. Others, on the contrary, for example, platinum, iron, tin, zinc, lead, alloy of lead, and tin, German silver, reflect all kinds of calorific rays in the same proportion, exactly as colorless opaque bodies do with regard to light.

The properties which distinguish calorific rays reflected from metals, from unreflected heat, are so far dependent on the source of heat, that differences,

for example, which exhibit themselves in a striking manner when solar heat is made use of, are diminished in the case of a Locatelli lamp, and completely disappear when the source or heat is a metallic cylinder not heated to redness.

The surface has the power either of causing the differences to appear in their maximum degree, or to disappear totally, according as the surface produces a diffuse or a regular reflection.

The same is true of the change of the angle of incidence. In the case of a rough metallic surface, as the angle of the rays with the surface diminishes, the reflection passes gradually from the diffuse to the regular, and at the same time the differences between the reflected and unreflected heat also gradually becomes less, until finally both have exactly the same character. — *Poggendorff's Annalen*, vol. ci., 1857.

GAUNTLETT'S IMPROVEMENTS IN THERMOMETRIC APPARATUS.

When it is considered of what immense value to mankind the great principle of heat has become in the present day, and how extensively that principle is applied in almost every branch of manufacturing industry, it is singular that hitherto no instrument of any practical utility has been devised to measure its intensity (beyond the limit of the ordinary mercurial thermometer), and to register its variations.

A thermometer recently patented by Mr. W. H. Gauntlett, an iron master of England, is constructed with a view to meet this deficiency, and to supply a want which has been long felt by iron masters and others engaged in manufacturing operations. Since the discovery made in the year 1819, that by heating the air forced into the blast furnace, a considerable saving of fuel could be effected in the smelting of minerals, the use of the hot blast has become almost universal; but it does not appear that, up to the present time, any reliable means has been employed to indicate and register the temperature of the air admitted into the furnace — a matter which is possibly of more importance in the economical production of metal than is generally supposed.

The principal feature in this pyrometer, and that which constitutes its chief value, is its capability of being used under pressure, as in a steam boiler, gasworks, hot-air ovens, or any confined medium where it would be impossible to apply the ordinary thermometer, as the sensitive part of this instrument, which is acted upon by the heat, does not require to be withdrawn, but communicates the result to the needle, which is exposed to view on the dial plate, and moves on the slightest variation of temperature.

In the construction of this instrument the well-known principle of the expansion of metals, as well as most other substances by heat, has been adopted. This principle has been brought into action in a very simple manner as follows: Two tubes or rods of different metals, which expand at different ratios when affected by heat, are firmly attached to each other at one end; the other end of these are left free, but connected by toothed gearing in the following manner: To the end of one tube is fixed a graduated

dial plate, on the axis of which is placed a pointer and pinion. To the end of the other tube is fixed a toothed rack, which communicates motion to the pinion. Hence, when the temperature varies, the tubes will vary in their expansion and contraction, and the pointer will indicate on the dial the temperature for the time being to which the thermometric apparatus has been subjected.

The advantage of the instrument consists in its capability of indicating degrees of heat beyond the limits of the ordinary mercury thermometer, its power being only limited by a temperature so high as to cause the metals of which it is composed to lose their rigidity. Its advantage also consists in the heat acting directly upon the sensitive part of the instrument, no intervening substance such as glass being made use of, as in the case of the mercury thermometer, unfitting that instrument to be applied to high temperature from the danger of its being destroyed by reason of the glass tube flying to pieces.

These pyrometers have been in use for some months past at several iron-works in the north of England, and we understand have been very highly approved of.

ON THE EFFECTS OF HEAT ON THE COLOR OF DISSOLVED SALTS.

Dr. Gladstone, in a paper before the British Association, Dublin, stated that if a colored salt be dissolved in water, heating the solution does not usually affect the color of it. In not a few cases, however, the color is rendered more intense, and altered somewhat in its character. Among the examples mentioned were ferricyanide of potassium, meconate of iron, chloride and bromide of palladium. In other cases, heating the solution produces apparently a total change of color; for instance, chloride of copper passes when heated from blue to green; chloride of nickel from a bluish to a yellowish green; sulphocyanide of cobalt, or chloride of cobalt dissolved in aqueous alcohol, from a pale red to a deep bluish purple. In all these instances heat causes the absorption of a larger quantity of rays by the solution; but this appears to depend sometimes upon some purely physical cause, at other times upon some chemical change. With ferricyanide of potassium, and similar salts, a certain thickness of the heated solution produces precisely the same effect on the spectrum as an increased thickness of the same solution when cold. With chloride of copper, and similar salts, the somewhat dilute solution when heated, produces the same effect on the spectrum as the same solution when concentrated and cold,—these salts being all of that character which is altered in color by the addition of water.

ON THE SOLIDIFICATION OF FLUIDS.

In a paper on the above subject, submitted to the British Association, Dublin, by Prof. Hennessy, the views put forward were deduced from some propositions in the dynamical theory of heat contained in the writings of Prof. W. Thomson and Prof. Clausius. The general result arrived at regarding the influence of pressure on a fluid so circumstanced as to lose no

part of the heat acquired by condensation would be, that so long as the matter continued in a fluid condition, the resistance to compression from this cause would be very small. If, however, the fluid were on the point of changing its state to that of solidity, the effect of the latent heat of fusion which by hypothesis could not be emitted, would interpose a resistance of great magnitude compared to that resulting from simple compression. The fused matter of which the interior of the earth most probably consists, would be under conditions similar to those mentioned, from the slow conducting power of the materials composing the earth, and from the pressure of all the outermost strata of equilibrium of the fluid upon those near the centre, and thus the influence of pressure in promoting solidification would be less than at its surface.

ON SIMULTANEOUS ISOTHERMAL LINES.

Professor Hennessy, in a paper before the British Association, at its recent meeting on the above subject, called attention to the importance of studying the simultaneous distribution of temperature. The movements of the winds, and in general almost all the daily perturbations of the atmosphere, depending much more on simultaneous conditions of temperature in different places than on the mean amount, over long periods, it would be desirable to attempt to trace the former class of lines when we attempt to obtain a complete connection between the different classes of atmospheric phenomena. If temperature were recorded at every station on the surface of the earth at the mean time corresponding to any given meridian, then a line traversing the places where such temperature were found to be equal, would be a simultaneous isothermal line. The forms of such lines would manifestly depend on the diurnal range of temperature at the several stations, as well as the several physical conditions influencing mean temperature. If the earth were absolutely at rest, and stripped of its fluid coverings, these lines would be circles, having their planes perpendicular to a line joining the centres of the earth and sun. This would be nearly the case in a body turning very slowly on its axis, like our satellite, in which Prof. Hennessy anticipated that observations would ultimately show a great diminution of heat radiated from the edges compared to the centre. With a more rapid motion of rotation, as in the case of the earth, the isothermals would be elongated in a direction parallel to that of the rotation. On introducing the influence of all the actual motions of the earth, and of the emissive and absorbing powers of the atmosphere, the ground, and the sea, the forms of these lines would be considerably modified. The forms of these lines on the land and sea would necessarily differ, and might be expected to present some important relations to the directions of land and sea breezes. It appears, in general, far more probable that a knowledge of the contemporaneous conditions of temperature at different places would assist in pointing to a connection between these phenomena and atmospheric perturbations rather than a knowledge of mean temperature. Atmospheric currents, whether vertical or parallel to the earth's surface, depend upon contemporaneous differences of tempera-

ture. A similar remark might be applied to many other important atmospheric phenomena, and these lines would also serve to indicate more clearly, or to lessen the possibility of the supposed connection between terrestrial magnetism and terrestrial temperature.

RECENT DISCOVERIES IN RELATION TO LIGHT.

The most important of the recent additions to the theory of *Light* have been those made by M. Jamin. It has been long known that metals differed from transparent bodies, in their action on light, in this, that plane-polarized light reflected from their surfaces became *elliptically polarized;* and the phenomenon is explained on the principles of the wave-theory, by the assumption that the vibration of the ether undergoes a *change of phase* at the instant of reflection, the amount of which is dependent on its direction and on the angle of incidence. This supposed distinction, however, was soon found not to be absolute. Mr. Airy showed that *diamond* reflected light in a manner similar to metals; and Mr. Dale and Professor Powell extended the property to all bodies having a high refractive power. But it was not until lately, that M. Jamin proved that there is *no distinction* in this respect between transparent and metallic bodies; that all bodies transform plane-polarized into elliptically-polarized light, and impress a change of phase at the moment of reflection. Prof. Haughton has followed up the researches of M. Jamin, and established the existence of *circularly-polarized* light by reflection from transparent surfaces.

The theoretical investigations connected with this subject afford a remarkable illustration of one of those impediments to the progress of Natural Philosophy, which Bacon has put in the foremost place among his examples of the *Idola.* I mean the tendency of the human mind to suppose a greater simplicity and uniformity in nature than exists there. The phenomena of polarization compel us to admit that the sensible luminous vibrations are *transversal,* or in the plane of the wave itself; and it was naturally supposed by Fresnel, and after him by M'Cullagh and Neumann, either that no *normal* vibrations were propagated, or that, if they were, they had no relation to the phenomena of light. We now learn that it is by them that the *phase* is modified in the act of reflection; and that, consequently, no dynamical theory which neglects them, or sets them aside, can be complete.

Attention has been lately recalled to a fundamental position of the wave-theory of light, respecting which opposite assumptions have been made. The vibrations of a polarized ray are all parallel to a fixed direction in the plane of the wave; but that direction may be either *parallel* or *perpendicular* to the plane of polarization. In the original theory of Fresnel, the latter was assumed to be the fact; and in this assumption Fresnel has been followed by Cauchy. In the modified theories of M'Cullagh and Neumann, on the other hand, the vibrations are supposed to be parallel to the plane of polarization. This opposition of the two theories was compensated, as respects the results, by other differences in their hypothetical principles; and both of them led to conclusions which observation has verified. There seemed,

therefore, to be no means left to the theorist to decide between these conflicting hypotheses, until Prof. Stokes recently, in applying the dynamical theory of light to other classes of phenomena, found one in which the effects should differ on the two assumptions. When the light is transmitted through a fine grating, it is turned aside, or *diffracted*, according to laws which the wave-theory has explained. Now, Prof. Stokes has shown that, when the incident light is *polarized*, the *plane of vibration* of the diffracted ray must differ from that of the incident, the two planes being connected by a very simple relation. It only remained, therefore, for observation to determine whether the *planes of polarization* of the incident and refracted rays were similarly related or not. The experiment was undertaken by Prof. Stokes himself, and he has inferred from it that the original hypothesis of Fresnel is the true one. But, as an opposite result has been obtained by M. Holtzmann, on repeating the experiment, the question must be regarded as still undetermined.

The difference in the experimental results is ascribed by Prof. Stokes to the difference in the nature of the gratings employed by himself and by the German experimentalist, the substance of the diffracting body being supposed to exert an effect upon the polarization of the light, which is diffracted by it under a great obliquity. I learn from Prof. Stokes that he proposed to resume the experimental inquiry, and to test this supposition by employing gratings of various substances. If the conjecture should prove to be well founded, it will greatly complicate the dynamical theory of light. In the mean time the hypothesis is one of importance in itself, and deserves to be verified or disproved by independent means. I would venture to suggest that it may be effectively tested by means of the beautiful *Interference-refractor* of M. Jamin, which the inventor has already applied to study the effects upon light produced by grazing a plate of any soluble substance inclosed in a fluid. It is well known that the refractive index of bodies increases with their density; and the theory of emission has even expressed the law of their mutual dependence. That theory, it is true, is now completely overthrown by the decisive *experimentum crucis* of M.M. Fizeau and Foucault. It was, therefore, probable, *à priori*, that this law — the only one peculiar to the theory — should be found wanting. Its truth has recently been put to an experimental test by M. Jamin. Water, it is known, has its maximum of density at about 40° of Fahrenheit; and accordingly, if Newton's law were true, its refractive index should also have a maximum value at the same temperatare. This has been disproved by M. Jamin, by observing the interference of two rays, one of which has passed through air, and the other through water; and thus the last conclusion of the emission-theory has been set aside. — *President's Address, British Association*, 1857.

EXPERIMENTS ON THE ACTINIC POWER OF THE SUN.

The following account of experiments made by Mr. J. J. Waterston, at Bombay, on the limit of the photographic power of the sun's direct light, have recently been communicated to the Astronomical Society, G. B. They were made with the view of obtaining data in an inquiry as to the possibility

of measuring the diameter of the sun to a very minute fraction of a second, by combining photography with the principle of the electric telegraph; the first being employed to measure the element space, the latter the element time. The result is, that about one twenty-thousandth of a second is sufficient exposure to the direct light of the sun to obtain a distinct mark on a sensitive collodion plate, when developed by the usual processes.

A circular wooden disc, nineteen inches diameter and half-an-inch thick, was mounted on an iron axis, so that it revolved easily by an impulse given by pressing the finger with a jerk on the outer edge.

About half-an-inch from the rim there was a circular aperture half-an-inch diameter, at the back of which the black paper was pasted. This paper was perforated by a needle, leaving a hole one-sixtieth of an inch diameter. It was found that the utmost velocity that could be given to the disc was five revolutions in a second; and after four seconds, it was reduced to three revolutions per second. At each revolution the space described by the hole was about fifty inches.

The revolving disc was placed behind the folding doors of a darkened chamber, so that when one wing was opened to the extent of a few inches, the sun's light struck the disc at the lower part of its revolution. Having made the preliminary arrangements, the observation was as follows: —

First, the maximum rotatory motion was given to the disc. A prepared sensitive plate was held close behind the disc (about a quarter of an inch from it), at the part where the sunshine struck. This plate was kept slowly moving in the direction of the radius of the disc. An assistant quickly opened and shut the door, allowing the sunshine to act for about a second. The latent image on the plate being developed, was found to consist of four or five concentric lines. This was repeated several times with different plates.

Taking the velocity of the aperture to be 150 inches per second, which is certainly under the mark, and the breadth of the hole one-sixtieth of an inch, the duration of the sun's full action on any one point must have been about one-nine-thousandth of a second.

The photographic process employed was as follows: —

"Albumen on glass iodized by tincture of iodine, twenty grains to one ounce of spirit.

"The silver bath, fifty grains nitrate of silver to one ounce water, and twelve drops nitric acid.

"The developing solution three parts water to one of acetic acid, and the mixture nearly saturated with protosulphate of iron."

The above was afterwards tried comparatively with the collodion process, and found to be considerably inferior in quickness of taking an impression, the ratio being two or three to one.

ON THE USE OF THE PRISM IN QUALITATIVE ANALYSIS.

Dr. Gladstone, in a paper read before the London Chemical Society, recently, remarked that hitherto the indications of color have played a very

subordinate part in qualitative analysis. This the author believed to have arisen from the fact, that chemists have been content with observing the color as it appears to the unaided eye. The color of any object, however, is the resultant of the various rays of the spectrum which it reflects or transmits; and by examining such objects with a prism strange peculiarities are frequently made manifest among substances of similar color, and strange analogies are often detected among substances which appear very different in color when their light is not thus analyzed.

Various methods of using the prism were described; that preferred from its easy application and great delicacy, was to view the light entering by a slit in the window shutters by means of a prism, the liquid to be examined being interposed in a wedge-shaped glass vessel, held in such a position that the line of light is seen through the varying thicknesses of the solution. In this way spectra of very characteristic configuration are obtained, all the rays being usually permitted to pass through the thinnest stratum of the liquid, but as the stratum gradually increases some of these rays are entirely absorbed, others are rendered faint in color, while others are transmitted with almost undiminished brilliancy. These spectra may be easily copied; indeed, the paper was illustrated by a number of diagrams done in colored crayons on black paper.

It has been partially recognized hitherto that all the compounds of a particular base or acid have the same effect on the rays of light. Thus, the various salts of nickel are green, those of zinc colorless. But the prism confirms the truth of this generalization in a very remarkable manner, and reveals not, indeed, an identity, but a distinct analogy in cases which were before thought to offer an exception. Many of these apparently exceptional instances were investigated. Thus there are two modifications of chromium salts in solution, the green and the blue, while other salts of this base always appear red; yet when these solutions are examined by the prism they all exhibit the same configuration of spectrum, the maxima of luminosity being always in the extreme red, and about the junction of the green and blue marked by the fixed line F; the differences of apparent color depend on slight variations in the relative quantity of these rays that are transmitted. Observations were likewise made on the blue and red salts of cobalt, and the green and blue salts of copper, and it was found that these changes depended solely on the quantity of water, while there were certain analogies even between the spectra afforded by these differently colored combinations of the same metal. Ferric salts all transmit the red ray with great facility; they were divided into several groups, the members of each group possessing other analogies likewise. All soluble chromates, though differing considerably to the unaided eye, give almost the same prismatic appearance. The changes that take place in a solution of litmus by the addition of an alkali, boracic acid, or a common acid were likewise examined, and the spectra transmitted in the different cases were shown to belong to the same type. When two substances combine, each of which imparts a particular color to its combinations, the resultant is not the compound of the two colors, but is

due simply to those rays of the spectrum which are transmitted by both. Instances of this both in mixtures and in chemical combinations were given.

From the fact of a particular ray being transmitted through a solution of unknown composition, we may infer that none of those bodies which in ordinary combination absorb that ray are present in any kind of combination. The prism also will frequently give more positive information respecting the composition of a substance, as was illustrated by the fact that salts of nickel, protoxide of iron, and of uranium, and some salts of chromium, copper, ferric oxide, and molybdenum, besides ferridcyanides and certain compound colored salts, are all green, yet they are easily discriminated by the prism. Dr. Gladstone believed that the prism might occupy a similar place in our laboratories to that now occupied by the blowpipe.

ON THE LIGHT OF SUNS, METEORS AND TEMPORARY STARS.

The following paper, by Mr. D. Vaughan, of Cincinnati, was read before the British Association at its last meeting: —

Modern science recognizes shooting stars, fire-balls, and meteoric stones, as bodies which enter our atmosphere from external space with immense velocities. From the great elevation at which these objects are luminous, it has been inferred that their light has little or no dependence on aerial action; and, indeed, the presence of the air alone could not account for the greatness of the illumination which marks their approach to the earth, but ceases when they enter the dense stratum of the atmosphere. The diameter of many luminous meteors has been estimated at two or three thousand feet; and the globe of light which they exhibited must have been several million times greater than the largest meteoric stone yet found on the earth's surface. It is supposed that these brilliant exhibitions are produced by cosmical masses several hundred yards in diameter, which, in traversing the planetary regions, occasionally sweep through the verge of our atmosphere, and, after casting a few fragments on the earth, continue their course through space. But the idea that such wandering bodies should graze our planet so often, without ever striking it directly or falling to its surface, is too extravagant to be seriously entertained. It would be far more likely that, during a naval engagement, a ship should be almost touched by several thousand balls, without being ever struck by a single one. Moreover, there is not the slightest evidence that meteorites ever perform such remarkable feats of precision, or experience so many narrow escapes from a collision with the earth, for, instead of being observed departing into space, they suddenly disappear after their encounter with the air. The small amount of solid matter which falls to the ground on these occasions is justly regarded as inadequate to evolve so vast a body of light by acting on the rarefied air at great elevations; but our globe seems to be invested with an atmosphere of ether, having far more wonderful properties. Astronomical investigations prove the existence of a rare medium pervading all space; and this subtle fluid cannot be wholly insensible to chemical forces, which alone could render it useful in nature's

economy. Extreme rarity would, indeed, prevent it from undergoing any chemical change in the inter-planetary regions; but it is compressed to a much greater density about the vast spheres by which space is tenanted. The atmospheres of this fluid enveloping the earth and the other large planets, are not sufficiently dense for chemical action, except in cases where they receive an additional pressure from meteoric bodies sweeping through them with wonderful rapidity. The evolution of light on such occasions depends not only on the size and velocity of the falling mass, but also on the direction in which it approaches the planetary surface; and observation shows that the most brilliant meteors move very nearly parallel to the horizon. But around the sun a much stronger attractive force gives this ethereal fluid the compression necessary for a constant chemical action, and a steady development of light; while the realms of space furnish inexhaustible supplies of the luciferous matter, and impart perpetual brilliancy to the great luminary of our system. It is not possible that the self-luminous condition of the sun could be maintained by any combustible, or light-yielding matter, of which it is composed. From a comparison of the relative intensity of solar, lunar, and artificial light, as determined by Euler and Wollaston, it appears that the rays of the sun have an illuminating power equal to that of 14,000 candles, at a distance of one foot; or of 3500,000000,000000,000000,000000 candles, at a distance of 95,000,000 miles. It follows that the amount of light which flows from the solar orb could be scarcely produced by the daily combustion of 200 globes of tallow, each equal to the earth in magnitude. A sphere of combustible matter much larger than the sun itself should be consumed every ten years in maintaining its wonderful brilliancy, and its atmosphere, if pure oxygen, would be expended before a few days in supporting so great a conflagration. An illumination on so vast a scale could be kept up only by the inexhaustible magazine of ether disseminated through space, and ever ready to manifest its luciferous properties on large spheres, whose attraction renders it sufficiently dense for the play of chemical affinity. Accordingly, suns derive the power of shedding perpetual light, not from their chemical constitution, but from their immense mass and their superior attractive power. We thus obtain some definite knowledge respecting the stupendous magnitude of the fixed stars; and making due allowance for their density, we may confidently pronounce the smallest stellar body several thousand times greater than the globe we inhabit. This theory gives considerable support to the views which many astronomers maintain, on different grounds, in regard to the relative brilliancy of the stars; for it appears that, though the self-luminous occupants of space are not necessarily equal in size, they differ much less than we might anticipate from an acquaintance with the members of our planetary system. That the light of the sun is furnished, not by its solid or liquid matter, but by its luminous atmosphere, has been proved very conclusively from the observations with Arago's polarizing telescope. There is also evidence that this luciferous envelop is constantly replenished by supplies of ether from space. The sun's rotation assists in effecting this object by expelling the fluid from its equatorial regions, and thus creating a corresponding influx at its poles.

A displacement by this means would evidently cause the solar atmosphere to advance constantly from its poles to its equator; and such a movement is indicated by the change in the position of the sun's spots, which, according to the observations of Peters for many years, are continually diminishing their heliocentric latitude. The progressive motion of the solar orb through space tends also to replenish its atmosphere with fresh material for the maintenance of its light; and the position of the large planets has some influence on the amount of ether which it receives from the celestial domain. The periodicity observed in the solar spots, and some changes exhibited by many variable stars, may be ascribed to an effect of this kind. But the result would be far more decided if a sun had large planets in its immediate vicinity; for the attraction of these bodies would alter the pressure on its ethereal atmosphere, and produce a corresponding variation in the development of its light. On this principle we may explain several phenomena connected with the variable stars; and I may remark, that Argelander regards many of their peculiarities as indicating, that planets revolving around some suns affect the generation of light in their photospheres. But a planet revolving in an orbit of the smallest size possible would be productive of more remarkable consequences. Sweeping through the ethereal atmosphere of the great central sphere, it would impart a sufficient degree of pressure for luciferous action; and exhibit, on a grand scale, the evolution of light which accompanies the visits of meteoric masses to the earth. From the great brilliancy of meteors which move in a horizontal direction, it is evident that a satellite revolving around a large globe, at a small distance above its surface, should be favored with all the conditions necessary for a sublime meteoric illumination; and it is probable that some of the bright tenants of space may shine by light originating from such a cause. Indeed, the resistance of the space-pervading medium must constantly diminish the orbits of all satellites; and, after innumerable years, bring them into such a proximity with their central bodies that such grand meteoric phenomena would be almost inevitable. If space contain dark systems (as is generally believed), the central orb which presides over each of them would become luminous, when one of its planets was passing through the final stage of existence. In a paper read at the last meeting of the American Association for the Advancement of Science, and published in the "Proceedings," (pp. 111—113), I have shown that the stability of satellites could no longer exist if their orbits were reduced to a certain limit; and that the attraction of the primary body would render them incapable of preserving a planetary form. In like manner, a member of one of the dark systems of space, when brought too near its central orb, would be likewise doomed to suffer a dismemberment; and the fragments resulting from the mighty wreck would immediately scatter into separate orbits. Instead, therefore, of closing its planetary career as one vast meteor, the attendant should form a host of meteoric masses, and thus send forth far greater floods of light into space. But the fragments, gradually assuming circular orbits, would ultimately form a ring similar to that around Saturn; and as this change advanced, the light should constantly decline until it ceased when

the ether partook of the motion of the fragmentary host, and became almost insensible to their pressure. It is to occurrences of this kind, which must occasionally take place in the wide domains of creation, that we may ascribe the appearance of temporary stars, and in doing so, we obtain a satisfactory explanation of the various peculiarities which they exhibit. The existence, on our own sphere, of the ether which acts so important a part in the scene of celestial wonders is indicated by certain electrical phenomena. On its presence seems to depend the evolution of light attending the passage of electricity through the vacuum of an exhausted receiver, and the light of the aurora borealis appears to be evolved by electric action from the ethereal fluid, which arrives at the polar regions from space. It is only by this hypothesis that we can account for the effect of a shooting star during an aurora, in lighting up certain parts of the vaults of heaven not previously illuminated (see Humboldt's "Cosmos" on Aerolites). It thus appears that the subtle medium which fills space is not to be regarded as a mere impediment to planetary motion, but as a useful agent in the course of Nature's operations, and as indispensable to our existence as the appendages of air and water which roll around our planet.

ON THE COLOR OF SALTS IN SOLUTION, EACH CONSTITUENT OF WHICH IS COLORED.

The following is an abstract of a paper on the above subject, read before the British Association, at its last meeting by Dr. Gladstone.

It is a general law that "all the compounds of a particular base, or acid, when in aqueous solution, absorb the same rays of light;" hence it may be deduced that when a colored base and a colored acid combine, the resulting salt will transmit only those rays which are not absorbed by either constituent,—or, in other words, only those rays which are transmitted by both. This was proved to be actually the case by a prismatic examination of compounds of chromic, permanganic, and carbazotic acids with copper, iron, nickel, uranium, and chromium. Though the compounds of chlorine, bromine, and iodine with hydrogen and most metals are colorless, the compounds of these halogens with gold, platinum, and palladium exhibit an absorption of light due to the halogen as well as that due to the metal. The same is true in respect to chlorides, bromides, and iodides of copper, iron, nickel, and cobalt, when these salts are dissolved in a minimum of water; but when more water is added the color changes, and the absorption due to the halogen no longer exists. In one or two of the cases examined a slight variation from the general law occurred; and ferrocyanide of iron forms a complete exception. The double chloride of platinum and copper shows the absorbent effect of all these constituents.

ON THE RELATIONS OF GOLD TO LIGHT.

During the year 1856, a paper on the relations of gold to light, was read before the Royal Institution, London, by Prof. Faraday. The abstract of

the investigations then announced was published in the Annual of Scientific Discovery for 1857, pp. 272, 273, 274. Since, another communication has been made by Prof. Faraday, on the same subject, in which he states that having since obtained some perfectly pure gold leaf, he has been enabled to fully verify his former observations. This was the more important in regard to the effect of heat in taking away the green color of the transmitted light, and destroying, to a large extent, the power of reflexion. The temperature of boiling oil, if continued long enough, is sufficient for this effect; but a higher temperature (far short of fusion) produces it more rapidly. Whether it is the result of a mere breaking up by refraction of a corrugated film, or an allotropic change, is uncertain. Pressure restores the green color; but it also has the like effect upon films obtained by other processes than beating. Corresponding results are produced with other metals. As before stated, *films* of gold may be obtained on a weak solution of the metal, by bringing an atmosphere containing vapors of phosphorus into contact with it. They are produced, also, when small particles of phosphorus are placed floating on such a solution; and then, as a film differing in thickness is formed, the concentric rings due to Newton's thin plates are produced. These films transmit light of various colors. When heated they become amethystine or ruby; and then when pressed, become green, just as heated gold leaf. This effect of pressure is characteristic of metallic gold, whether it is in leaf, or film, or dust. Gold wire, separated into very fine particles by the electric *deflagration*, produces a deposit on glass, which, being examined, either chemically or physically, proves to be pure metallic gold. This deposit transmits various colored rays: some parts are gray, others green, or amethystine, or even a bright ruby. In order to remove any possibility of a compound of gold, as an oxide, being present, the deflagrations were made upon topaz, mica, and rock crystal, as well as glass, and also in atmospheres of carbonic acid and of hydrogen. Still, the results were the same, and ruby gold appeared in one case as much as in another. Being heated, all parts of the deposit became of an amethystine or ruby color; and by pressure, these parts could be changed so as to transmit the green ray. The production of *fluids*, consisting of very finely divided particles of gold diffused through water, was spoken of before. These fluids may be of various colors by transmitted light from ruby to blue; the effects being produced only by diffused particles of metallic gold. If a drop of solution of phosphorus in bisulphide of carbon be put into a bottle containing a quart or more of very weak solution of gold, and the whole be agitated, the change is brought about sooner than by the process formerly described; or if a solution of phosphorus in ether be employed, very quickly indeed; so that a few hours' standing completes the action. All the preparations have the same qualities as those before described. The differently colored fluids may have the colored particles partially removed by filtration; and so long as the particles are kept by the filter from aggregation, they preserve their ruby or other color unchanged, even though salt be present. If fine isinglass be soaked in water, then warmed to melt it, and one of these rich fluids be added, with agitation, a ruby jelly fluid will be obtained, which, when suffi-

ciently concentrated and cold, supplies a tremulous jelly; and this, when dried, yields a *hard ruby gelatine*, which being soaked in water, becomes tremulous again, and by heat and more water yields a ruby fluid. The dry hard ruby jelly is perfectly analogous to the well-known ruby glass, though often finer in color; and both owe the color to particles of metallic gold. Animal membranes may, in like manner, have ruby particles diffused through them, and then are perfectly analogous in their action on light to the gold ruby glass, and from the same cause. When a leaf of beaten gold is held obliquely across a ray of common light, it *polarizes* a portion of it; and the light transmitted is polarized in the same direction as that transmitted by a bundle of thin plates of glass; the effect is produced by the heated leaf as well as by the green leaf, and does not appear to be due to any condition brought on by the heating or to internal structure. When a polarized ray is employed, and the inclined leaf held across it, the ray is affected, and a part passes the analyzer, provided the gold film is inclined in a plane forming an angle of 45° with the plane of polarization. Like effects are produced by the films of gold produced from solution and phosphorus, and also by the deposited dust of gold due to the electric discharge. The same effects are produced by the other deflagrated metals so long as the dusty films are in the metallic state. As these finer preparations could be held in place only on glass or some such substance, and as glass itself had an effect, it was necessary to find a medium in which the power of the glass was nothing; and this was obtained in the bisulphide of carbon. Here the effect of gold upon the ray of light which was unaffected by the glass supporting it was rendered very manifest, not only to a single observer, but also to a large audience. The object of these investigations was to ascertain the varied powers of a substance acting upon light, when its particles were extremely divided, to the exclusion of every other change of constitution. It was hoped that some of the very important differences in the action upon the rays might in this way be referred to the relation in size or in number of the vibrations of the light and the particles of the body, and also to the distance of the latter from each other; and as many of the effects are novel in this point of view, it is hoped that they will be of service to the physical philosopher.

As to the quantity of gold in the different films or solutions, it can at present only be said that it is very small. Suppose that a leaf of gold, which weighs about 0·2 of a grain, and covers a superficies of nearly ten square inches, were diffused through a column having that base, and 2·7 inches in height, it would give a ruby fluid equal in depth of tint to a good red rose, the volume of gold present being about the one five hundred thousandth part of the volume of the fluid; another result gave 0·01 of a grain of gold in a cubic inch of fluid. These fine diffused particles have not as yet been distinguished by any microscopic power applied to them.

PHOTOHELIOGRAPH.

Under the auspices of the Royal Society, G. B., a photographic apparatus for registering daily the position of the spots upon the sun's disc, as sug-

gested by Sir John Herschel,* has recently been constructed and placed in the observatory at Kew. The object-glass of this instrument is three and four-tenth inches aperture, and fifty inches focal length; it is not corrected for achromatism in the ordinary manner, but so as to produce a coincidence of the visual and photogenic foci. The secondary objectives for magnifying the image produced by the principal object-glass are of the Huyghenian form. They are three in number, producing respectively images of the sun, three, four and eight inches in diameter. Between the two lenses of each of these secondary object-glasses, is inserted a diaphragm plate, carrying the fixed micrometer wires, which are of platinum; these wires are four in number, two at right angles to the other two. One of the wires of each pair is in such a position that they may both be made tangential to the sun's image, while the other two cross at a point situated near the sun's centre. By means of these wires, the distance in arc between each pair having been once for all ascertained astronomically for each secondary object-glass, it will be easy to determine all the data necessary for ascertaining the relative magnitudes and positions of the sun's spots. These micrometer wires are under the influence of springs, so as to preserve a tension upon them when expanded by the sun's heat, and thus to keep them straight. The principal and secondary object-glasses are not mounted in an ordinary cylindrical tube, but in a pyramidal trunk square in section, five inches in the side at the upper end, which carries the principal object-glass, and twelve inches in the side at the lower end, which carries the photographic plate-holder and the usual ground glass screen for focusing. This trunk is firmly supported by a declination axis of hard gun metal two and a half inches in diameter; it is furnished with a declination circle ten inches in diameter, reading to one minute of arc, and has a clamp and screw motion for fine adjustment in declination.

The polar axis is driven by a clock driver, which answers perfectly, and is easy of regulation to the greatest nicety, so that the sun's limb remains for a long period in contact with the tangential wires.

The polar axis of the telescope is carried by a dial-plate, which fits on the top of a hollow column of cast iron, the section of which is a parallelogram. This column is securely fastened to the stone foundation. The instrument is mounted within the rotating dome of the Kew Observatory.

The telescope and its mechanical appliances may be said to be perfect so far as they go, but experience will undoubtedly suggest several minor alterations and additions before the telescope is brought practically to work. The photographing of such minute objects as the sun's spots will require at all times the utmost skill and care of an accomplished photographer, even when the telescope has been fairly started. The difficulties yet to be mastered must occupy some considerable time. The first attempts have been confined to the production of negative photographs, but in consequence of the imperfections always existing in the collodion film, it has been deemed advisable to make attempts to produce positive pictures, and recourse may ultimately have to be made to the daguerreotype process.

* See Annual of Scientific Discovery, 1855, p. 203.

IMPROVEMENTS IN LENSES AND REFLECTORS.

It is well known that Buffon, desirous of repeating the experiment of Archimedes, with a burning glass, endeavored to construct a lens of water, of large diameter. Two plates of glass of great thickness were curved by the heat of a concave metallic plate, worked and polished, and then fitted together with a border of metal and filled with distilled water. Buffon thus made a lens one meter in diameter and of great power. But he pursued it no further, because of the difficulty of the work, and the enormous expense of polishing the rough surface of the glass, the material being also rendered brittle by the second heating. Since then in England, and more lately in France, there have been attempts to blow a glass lens in a mould of metal made in two halves. But the result has been imperfect, the glass uneven, giving no distinct focus.

There has however been a recent improvement by Messieurs Lemolt and Robert, which is of great importance. It consists in using for constructing the lenses, a circular plate of glass, and a section from a sphere blown with great care, applying this to the plate and closing them together in a circle of metal, and putting water between, or some other transparent liquid. It forms a plano-convex lens, which may be economically made, and has the purity and perfection nearly, without the cost, of lenses of massive glass. Lemolt and Robert have also made improvements in reflectors, employing sections of glass more or less concave, cut from a sphere, in the same way as above mentioned, and having on the convex part a rich plating of silver from electric deposition. These reflectors can be cheaply made and require little care. Lenses and reflectors of this kind have been used on the rail-roads of Paris. By combining the two, a new kind of lamp has been constructed, giving results of unexpected brilliancy, which have already been brought into use on board ships and at the entrances of ports as well as on rail-roads. A water lens thirty-eight centimeters will send its rays to a distance of twenty kilometers along a railway, producing the effect of a light-house light of the second order. — *Silliman's Journal.*

SIMPLE METHOD OF DETERMINING THE FOCAL LENGTH OF SMALL CONVEX LENSES.

The following is a communication recently made to the Royal (G. B.) Astrominical Society, by the Rev. T. W. Webb.

The determination of the focal length of a small convex lens is a matter of considerable difficulty, at least in the hands of an amateur. Not only is the process of direct measurement a delicate and somewhat troublesome one, but the result is not satisfactory, as it is complicated with uncertainties arising from the amount of spherical aberration, which with a large angle of aperture may have a considerable effect; from the thickness of the lens; and from the difference of the measure from the centre and from the margin of the posterior surface. These difficulties, it is true, are avoided, as to the usual object of such measurements, by the employment of the dynameter, or

any equivalent contrivance by which the focal image is measured instead of the focal length; but, as these optical means are not always at hand, it may perhaps be of some use to explain a mode of measurement practised by myself very successfully more than twenty years ago. The requisite apparatus, if it can be so termed, will be described in its original simplicity; a little ingenuity would easily improve it: but even in its first rude trial it was found adequate to its object. Three pieces of cork are perforated by a knitting needle, so as to slide along it. To the centre one is attached, in a vertical position, and with its axis parallel to the knitting-needle, the lens to be measured; in each of the others is inserted a piece of a sewing-needle, with the point uppermost, and having its length so regulated that a line joining these points would pass, as nearly as may be, through the centre of the lens. The cork discs carrying these needles are then moved backwards and forwards, till the inverted image of the one needle's point, formed by rays passing through the lens, is seen coincident and equally distinct with the other needle's point, when both are viewed at once through a tolerably strong magnifier applied to the eye, and directed towards the lens. Then, if the needle-points are sensibly equidistant on each side of the lens, a condition which can be quite sufficiently attained in the course of a few trials, it is evident that they occupy the conjugate foci, and the distance between them being carefully measured with compasses, will be, as a very simple proposition in optics will show, four times the amount of the focal length of the lens for parallel rays. The apparent defect of this method is the uncertainty whether the points, when the image of one is formed close to the other, are equidistant from the lens, the setting of which, or its form, unless equally convex on each side, may render actual measurement unsatisfactory.

ON A TELESCOPE SPECULUM OF SILVERED GLASS.

The following communication was presented to the British Association, Dublin, by M. Leon Foucault: The astronomical refractor compared with the reflecting telescope of the same dimensions, has always had the advantage of giving more light; the pencil of rays which fall on the object-glass pass through it for the most part, and are employed almost entirely in the formation of the image at the focus; while on the metal mirror a part only of the light is reflected in a converging pencil, which loses still more by a second reflection being brought back towards the observer. However, as the reflecting telescope is essentially free from aberration of refragability, as the purity of its images depends only on the perfection of a single surface, as with regard to focal length it possesses a greater diameter than the refracting telescope, and thus partly regains the light wasted by reflexions — some observers continue to give it the preference, chiefly in England, over the refracting telescope for the examination of celestial objects. It is certain that at this moment, and despite the multiplied improvements in the manufacture of large glasses, the most powerful instrument directed towards the heavens is a telescope with a metal speculum. The telescope of Lord Rosse is six feet English in diameter, and its focal distance is fifty-five feet. Possibly the reflect-

ing instruments would have gained the superiority could the metal take as durable a polish — could it be as well worked as the glass, and were it not heavier. Placing thus in parallelism the two sorts of instruments, and discussing their respective qualities and defects, I finished by conceiving that the telescope with a glass would possess every advantage, if the mirror being once shaped and polished we could communicate to it the metallic brilliancy, in order to obtain from it images as luminous as those of the refracting telescopes. This thought, which at first appeared a fiction of imagination, was soon converted into a satisfactory reality. The glass being cut by an experienced optician, and thoroughly polished, is ready to be covered by Drayton's process with a very thin uniform coating of silver. This metallic coating, which when taken out of the bath in which it is formed is dull and dark, is easily brightened by rubbing with a skin lightly tinged with oxide of iron, and acquires in a short time a very brilliant lustre. By this operation the surface of the glass is wholly of metal, and becomes vividly reflective, not exhibiting under severest tests the slightest alteration in form. To procure a disc of glass with concave surface perfectly finished, I applied to Mr. Secretan, who had the kindness to provide for me a clever workman. On the other hand, to be able to obtain a deposit of silver, I had recourse to the owners of the English patent, M. Power and M. Robert, who furnished me with the silvery solution, giving at the same time the fullest instructions as to how I might soonest succeed. My mirror being silvered, and having acquired a polish of steel, I formed a telescope of it of ten centimètres diameter and fifty centimètres focal length. This little instrument supports well the eye-glass, which magnifies 200 times, and compared with the reflecting telescope of one mètre, gives a very sensibly superior effect. Wishing to learn the proportion of light usefully reflected by the layer of silver deposited on the glass, and afterwards polished, or, at least, to compare the intensity of a pencil of rays reflected by a surface thus prepared with that of one transmitted by an equal surface from the object-glass of a refracting telescope, I accomplished the matter without difficulty by means of a photometer with divisions, which I had employed on another occasion. The result of this operation insures a decided advantage to the new telescope. The pencil of rays reflected on the silvered glass is equal to 90 per cent. of those transmitted through an object-glass of four partial reflections; so that the new instrument avails itself of the overplus of light, which, on account of the greater diameter of the mirror, concurs efficiently to the formation of the focal image. Diameters equal, the telescope with glass is by one-half shorter than the other instrument, — with equal lengths, it bears a double diameter, and collects three and a half times more light. Considered in another point of view, the new combination is distinguished in this, that it produces all its effect without the concurrence of those numerous conditions required to obtain a certain degree of perfection in any instrument, whether reflecting or refracting telescope. The reflecting telescope, above all, requires that the constructor of it, at one and the same time, pay particular attention to the homogeneity of the two sorts of glass which form the object-glass, their refracting and dispersive powers, the combination of

curves, the centerage and the execution of four spherical surfaces. In the new telescope, on the contrary, the glass, serving not as a middle refractor, but only to support a very thin layer of metal, the homogeneity of the mass is by no means required, and the most ordinary glass of sufficient thickness worked with care, affords a concave surface, which when silvered and polished furnishes of itself and by reflexion excellent images. There is one strong objection to the metal mirrors, — it is, that they become oxidized in time, and are tarnished by contact with the air. Eight months I have silvered mirrors, which have not yet undergone any sensible alteration. Will they preserve this state of perfection a still longer time? The experiment has not yet been sufficiently prolonged to decide one way or the other; but even should the lustre of the mirror become weaker, there is no difficulty in recurring to the same means for re-establishing it, by which it had been at first obtained. In fine, should the depth of the silver be altered, the operation of depositing it is so easy and prompt, that it can easily be repeated. To resume, the new instrument compared with the refracting telescopes gives, at much less cost, more light, more distinctness, and is free, like the reflecting telescope, from all aberration of refrangibility.

Professor Stoney asked what the material of the polisher used by M. Foucault was, and gave various reasons for doubting that the method proposed by the author would ever produce a speculum the defining power of which could approach to that of specula ground and polished by the methods devised and executed by Lord Rosse. — Mr. Grubb stated, that if the one three thousandth of an inch spoken of by M. Foucault was meant to convey an idea that that dimension bore any relation to the quantity removed in the process of polishing, his own experience would enable him confidently to deny its power of producing a speculum of accurate defining power, as in the polishing process thicknesses of a forty and fifty thousandth part of an inch became important thicknesses. — The President, Dr. Robinson, said, that when M. Foucault had visited Lord Rosse, as he was about to do, and had seen the apparatus which he used for grinding and polishing even monster specula, he would not, he felt well assured, consider these operations on metals so formidable as they now appeared to him; he would find that to polish the great speculum of six feet diameter, in which operation it was brought to the true figure for best definition, occupied only a matter of about five hours from the time it was placed upon the machine.

ON THE CENTERING THE LENSES OF COMPOUND OBJECT-GLASSES OF MICROSCOPES.

The following is a report of a communication made by Sir David Brewster to the British Association at its last meeting at Dublin, on the above subject.

In studying the subject of diffraction, as seen through the microscope, I was led to believe that in the best object-glasses now made, the axes of the individual lenses were now coincident. I have no means or learning by what process the optician centres his lenses, and groups of lenses, but it must be a very delicate one, when we consider the small size of the lenses

and the great depth of their curves; and I have no doubt that, however imperfect, it is one which is anxiously and carefully applied. You are, no doubt, acquainted with Dr. Wollaston's interesting paper "On the Concentric Adjustment of a Triple Object-Glass," (*Phil. Trans.*, 1822, p. 32) 45 inches in focal length, executed by the celebrated John Dollond, and regarded as one of his best works. By a process which he has described, Dr. Wollaston found that it was very imperfectly centered; and, contrary to the advice of his friends, he separated the lenses, and by applying two pairs of adjusting screws to the edges of each lens, he placed their axes in the same line, and, to use his own words, "he restored his object-glass to such correct performance" that it was "capable or either separating very small and nearly equal stars, as those of forty-four *Bootis* and σ *Coronæ*, or of exhibiting the minute secondaries of β *Orionis* and twenty-four *Aquilæ*, with as much distinctness as the state of the air would admit." Dr. Wollaston adds, "that the actual limit to its powers cannot be fully ascertainted, excepting under such favorable conditions of the atmosphere as do but rarely occur." If such a distinguished artist as Dollond failed in centering a group of three lenses, about four inches in diameter, and with comparatively flat curves, how much more difficult must it be to center the six minute lenses of an achromatic object glass one-eighth or one-twelfth of an inch in focal length: and if such results were obtained by the correction of his error, how superior must the microscope be in which the concentric adjustment of its lenses is effected? While opticians, indeed, confine themselves to the use of only two kinds of glass, of different refractive and dispersive powers, we can hardly expect much improvement in the microscope, unless by the substitution of achromatic lenses in the eye-piece, and by an infallible method of centering each lens, and each group of lenses in the instrument. The successful application of two pairs of adjusting screws to each of six lenses, and also to those of the eye-piece, may be a difficult task, but it is not beyond the powers of mechanism. It is very obvious that Dr. Wallaston's method of examining the centering of a triple object-glass is wholly inapplicable to the object-glass of a microscope. In submitting to examination an object-glass made by a distinguished optician, it was necessary to use a microscopic picture of the sun, and to examine the position of its images as reflected from the various surfaces of the lenses by means of a microscope, the object-glass of which was brought in contact with the outer lens of the object-glass to be examined. By separating the two object-glasses, I observed in succession a series of twenty-four images appearing and disappearing in succession. These images occupied different parts of the field, and I could not succeed by the most careful adjustment of the apparatus employed in placing them in the same axis. These images had various sizes, and were in various states of color, some highly colored, and some purely white. They had also various sizes, many with fine planetary discs, of different magnitudes, some like the smallest fixed stars which it was difficult to descry, and almost all of them exhibiting the most beautiful concentric diffracted rings when put out of focus. Two or three images often appeared in the same part of the field, in immediate succession, while

similar pairs arose at a distance from each other. Although I often succeeded in uniting two or more of these images, yet the effect of this was to place others at a greater distance; and I had no hesitation in coming to the conclusion, that the lenses of the object-glass which produced these images were imperfectly centered. Having had occasion to see at the Paris Exposition, and more recently at Florence, the superior performance of Professor Amici's microscopes, I cannot omit the present opportunity of urging philosophers and opticians, as I have often done, to correct the colors of the secondary spectrum by fluids or solids of different dispersive powers. Professor Amici has done this. In his object-glasses, numbers one and two, of low powers, he employs four different refractive and dispersive substances. In his powers numbers three, four and five, he employs five such substances; and in his highest power, number six, he employs six. In recommending, as I have often had occasion to do, the employment of diamond and other gems in the construction of compound as well as simple microscopes, I have been met with the objection that they are too expensive for such a purpose, and they certainly are for instruments intended merely to instruct and amuse; but if we desire to make great discoveries, to unfold secrets yet hid in the cells of plants and animals, we must not grudge even a diamond to reveal them. If Mr. Cooper and Sir James South have given a couple of thousand pounds for a refracting telescope, in order to study what have been mis-called "dots" and "lumps" of light on the sky; and if Lord Rosse has expended far greater sums on a reflecting telescope for analyzing what has been called "sparks of mud and vapor" encumbering the azure purity of the heavens, why should not other philosophers open their purse, if they have one, and other noblemen sacrifice some of their household jewels to resolve the microscopic structures of our own real world; — to unravel mysteries most interesting to man; and disclose secrets which the Almighty must have intended that we should know?

ON THE PHOTOGRAPHIC EFFECTS OF LIGHTNING.

The following is an abstract of a paper on the above subject recently presented to the Royal Society, Eng., by Andrés Poey, director of the observatory at Havana. The first, though not the earliest authentic mention of this singular phenomenon was made by Benjamin Franklin, in 1786, who frequently stated that about twenty years previous a man who was standing opposite a tree that had just been struck by a thunderbolt, had on his breast an exact representation of that tree. A similar case is mentioned by the "Journal of Commerce," New York, on the 26th of August, 1853. "A little girl was standing at a window, before which was a young maple tree; after a brilliant flash of lightning, a complete image of the tree was found imprinted on her body. This is not the first instance of the kind." M. Raspail, in 1855, has also mentioned another instance. He says that a boy having climbed a tree for the purpose of robbing a bird's nest, the tree was struck, and the boy thrown upon the ground; on his breast the image of the tree, with the bird and nest on one of its branches, appeared very plainly.

M. Olioli, a very learned Italian, brought before the Scientific Congress at Naples the following four cases of impressions made by lightning. In September, 1825, lightning struck the foremast of the brigantine *St. Buon Circo*, in the bay of Arniro; a sailor sitting under the mast was struck dead, and on his back was found an impression of a horseshoe, similar even in size to that fixed at the mast head. On another occasion, a sailor standing in a similar position, had on the left of his breast the impression of a number 44, with a dot between the two figures, being in all respects the same as a number 44 that was at the extremity of one of the masts. On the 9th of October, 1836, a young man was found struck by lightning. He had on a girdle, with some gold coins in it; these were imprinted on his skin in the same manner they were placed in the girdle; thus a series of circles with one point of contact was plainly visible. The fourth case happened in 1847. Mrs. Morosa, an Italian lady of Lugano, was sitting near a window during a thunder-storm, and perceived the commotion, but felt no injury; but a flower which happened to be in the path of the electric current was perfectly re-produced on her leg, and there it remained permanently. M. Poey also mentions the following instance, which came under his personal observation in Cuba: — On the 24th of July, 1852, a poplar tree in a coffee plantation being struck by lightning, on one of the large dry leaves was found an exact representation of some pine trees that lay at the distance of 339 metres (three hundred and sixty-seven yards, nine inches). As to the theoretical explanation of lightning impressions, Mr. Poey thinks that they are produced in the same manner as the electric images obtained by Moser, Riess, Karster, Grove, Fox Talbot, and others, either by statical or dynamical electricity of different intensities. The fact that impressions are made through garments is easily accounted for when we remember that their rough texture does not prevent the lightning passing through them, with the impression it has received. To corroborate this view, Mr. Poey mentioned an instance of lightning falling down a chimney, and passing into a trunk, in which was found an inch depth of soot, which must have passed through the wood itself.

PHOTOGRAPHS OF THE FIXED STARS.

At a recent meeting of the American Academy, Boston, Mr. G. P. Bond communicated the results of an examination of the photographs of the star Mizar (ζ Ursa Majoris, with its companion, and the neighboring star Alcor;) specimens of which were exhibited.

Daguerreotype images of the star Vega (α Lyræ) were obtained at the Observatory of Harvard College by the well known artist, Mr. J. A. Whipple of Boston, on the 17th of July, 1850, and subsequently impressions were taken from the double star, Castor, exhibiting an elongated disc, but no distinct separation of its two components. These were the first, and, till very recently, the only known instances, of the application of photography to the delineation of the fixed stars.

A serious difficulty was interposed to further progress by the want of suitable apparatus for communicating uniform sidereal motion to the telescope.

This has now been supplied by replacing the original Munich clock of the great equatorial of the Observatory by a new one, on the principle of the spring governor, invented by the Messrs. Bond. This clock, which was made by Messrs. George and Alvan Clark of East Cambridge, carries the telescope with admirable evenness and regularity of motion.

Immediately upon its completion, at the invitation of the Director of the Observatory, Messrs. Whipple and Black commenced a new series of experiments, and have succeeded in transferring to the plate, by the collodion process, images of the fixed stars to the fifth magnitude, inclusive, with singular and unexpected precision.

The most remarkable instances of their success are the simultaneous impressions of the group of stars composed of Mizar of the second magnitude, its companion of the fourth, and Alcor of the fifth magnitude.

Mr. Bond then presented a series of measurements of the angular distance of the companion from Mizar, taken from the plates with a micrometer microscope. These measurements compared, with those given by Struve, as the result of observation and calculation, showed the probable error of a single photographic distance to be $\pm 0''.12$, or quite as small as that attributed by Struve to a single direct measurement. The former method has thus in its first efforts attained the limit of accuracy beyond which it is not to be expected that the latter can ever be sensibly advanced. But the photographic process holds out a much better promise.

The two principal sources of error by which it is affected are spots on the glass plate, or impurities in the coating in the neighborhood of the images, and slight departures from symmetry in their form, as yet noticed only when the plate has been exposed too long to the action of the light. The latter has been the case with most of the plates from which the above measurements have been taken, and they may in consequence be slightly affected. It is certainly to be anticipated, that, by the exercise of more care in regulating the time of exposure, the symmetry of the images can be secured. A microscopic examination will in most cases serve to distinguish accidental spots in the coating, or on the glass, from the molecules, which, by their aggregation, show the action of light.

The real difficulty, perhaps insurmountable, which now prevents a most extensive application of photography to astronomy, is the deficient sensitiveness of the processes in use. Unless photographs of stars as low, at least, as the eighth magnitude can be obtained, its use must be restricted to comparatively few double stars. Should, however, this impediment be overcome, and photographic impressions be obtained from stars between the sixth and eleventh magnitudes, as has already been done for those between the first and the fifth, the extension given to our present means of observation would be an advance in the science of stellar astronomy of which it would scarcely be possible to exaggerate the importance.

PHOTOGRAPHS FOR WOOD ENGRAVING.

By a process invented by La Clemand, of Paris, the wood is first placed with its surface on a solution of alum, and dried; it then receives with a

soft brush, a coating composed of animal soap, gelatine, and alum, upon all its faces; when the coating is dry, the surface which is to receive the picture is placed for some minutes in a solution of muriate of ammonia (sal-ammoniac), then dried; then on a bath of nitrate of silver of twenty per cent., and then dried. A cliché upon glass or paper is then applied on the wood by means of a peculiar frame, permitting the process of the reproduction to be watched. When satisfactory, the picture is fixed by means of a saturated bath of hyposulphite of soda. A few minutes is enough; it is then washed for only five minutes. The first coating preserves the wood from moisture; and eight months of experience have proved to the inventor that the employment of alum and a hyposulphite, in place of destroying the wood, gives it a great strength favorable to the engraving. — *Comptes Rendus, October*, 1857.

Another process, recently patented by R. Rice, of Worcester, Mass., and which is now practically applied, consists in preparing the wooden blocks first of all with a thin solution of asphaltum or bitumen, ether and lampblack, rubbed into the pores of the wood. This ethereal solution of asphalt is put on the surface of the block with a rag, brush or sponge, and then some fine lampblack is also rubbed in dry; the surface of the block is afterwards polished on a cushion, when it acquires a smooth, jet black, glossy appearance. After this, it is treated by the common photographic process; namely, coated with collodion rendered sensitive by nitrate of silver, then put into the camera, the picture taken, then fixed and dried in the usual manner.

ON PHOTO-GALVANOGRAPHY, OR ENGRAVING BY LIGHT AND ELECTRICITY.

The following is a detailed description, copied from the specification of the patent, of the very remarkable method of engraving, by the combined process of photography and electricity, invented by M. Pretsch, late manager of the imperial printing office at Vienna. A brief notice of this invention was given in the Annual of Scientific Discovery for 1857, page 211.

My invention, says M. Pretsch, consists in adapting the photographic process to the purpose of obtaining a raised or sunk design, on a glass or other suitable plate covered with glutinous substances, mixed with photographic materials, which design can then be copied by the electrotype process, so as to procure plates suitable for printing purposes. The operator first coats a glass plate with a gelatinous or glutinous solution, suitably prepared with chemical ingredients, sensitive to light, as follows: — One part of clear glue is soaked in about ten parts of distilled water, but the quantity of water depends upon the strength of the glue, and the state of the atmosphere. Meanwhile, there are prepared three different solutions, viz: a very strong solution of bichromate of potash, a solution of nitrate of silver, and a weak solution of iodide of potassium. The glue is dissolved by heat, and a small quantity of it is added to each of the two solutions of silver and iodide. The remaining greater portion of the glue is kept warm, the solution of bichromate of potash added, and well mixed. After which the small

portion of the glue with silver is added, and also mixed well, and allowed about ten minutes' time for combining. Finally, the small portion of the glue with the iodide is added, the whole mixture strained, and it is then ready to be poured on the plates of glass or other suitable material. When dry, the coated plate is ready for exposure. The photographic picture, the drawing, print, or other subject to be copied, being laid on the prepared coated surface, they are to be placed together in a photographic copying frame, and exposed to the influence of the light. After a sufficient exposure, which is exceedingly variable, according to the intensity of the light, the plate is taken out from the copying frame, when it will be found to exhibit a faint picture on the smooth surface of the sensitive coating. It is then washed with water, or a solution of borax, or carbonate of soda, as may be necessary. The whole image comes out in relief with all its details, and, when properly done, with all its brilliancy.

If the original is a photograph, chalk, sepia, or Indian ink drawing, the copy represents the different tints in grains; if in lines, the copy will reproduce the lines.

When sufficiently developed, it must be washed with spirits of wine. The surplus moisture is removed, and the plate is covered with a mixture of copal varnish, diluted with spirits of turpentine. After some time, the superfluous varnish must be removed by oil of turpentine, and the plate treated again, or immersed in a very weak solution of tannin or other astringent liquid. During this part of the process the plate must be carefully watched, and removed as soon as the picture or design is considered sufficiently raised; it is then washed in water and dried. In this state the plate is ready to be copied. This may be effected by the customary methods of rendering the coating conducting, and placing it in the electrotype apparatus, producing an intaglio copper plate; or, if first moulded, the intaglio mould furnishes the means of obtaining a relievo plate by electro-deposition in a similar way. To produce a *sunk* design on the prepared plates, I proceed as before, but after washing with the spirits of wine, the plate must be dried on a warm place, and in due time the picture or design will appear sunk like an engraved plate. The printing plates are produced as before described.

If an intaglio plate is made, it may be printed from, at the common copper-plate printing press; on the other hand, the relievo plate may either serve as the matrix for producing an intaglio printing plate, or it may be itself employed in "surface" printing, like a wood-cut. In the latter case, the narrow lines of the impression being sufficiently raised, the broad white spaces must be cut out on the printing plate, or built up in the matrix. The common well known stereotype process also affords another means of producing the necessary plate.

PHOTOGRAPHS IN FACTITIOUS IVORY.

An invention by Mr. J. E. Mayall, the well-known London photographer, relates to the use of artificial ivory for receiving photographic pictures in-

stead of glass or paper. This artificial material, which possesses all the properties and beautiful finish of ivory, and allows of any subsequent tinting of the image, and the obtainment of superior softness in the semitints, is what is known in France as Pinson's artificial ivory, consisting of a compound of gelatine and alumina. This material is prepared in the form of slabs, for the photographer's use, in this way: The tablets or slabs are composed of gelatine or glue in its natural state, and are immersed in a bath of alumina, which is held in solution by sulphuric or acetic acid; by this means a complete combination takes place between the alumina and the gelatine or glue. The tablets or slabs should remain in the bath a sufficient time to become thick enough for the purpose for which they are required, and to allow the alumina to entirely penetrate them and incorporate itself therewith; they are then removed and allowed to dry or harden, when they may be dressed and polished by any of the ordinary and well-known processes for polishing ivory.

Artificial ivory tablets, capable of bearing a fine polish, may also be made by mixing alumina directly with gelatine or glue; but this process is not so satisfactory as the process hereinbefore described, since the thickening produced by the admixture of the alumina with the gelatine, renders the manufacture of the sheets both difficult and expensive.

Another composition of artificial ivory which is employed, consists of equal portions of bone or ivory dust, used either separately or combined, and albumen or gelatine, the whole being worked into a paste, and afterwards rolled out into sheets by suitable rolling or flattening mechanism. The sheets are then allowed to harden by exposure to the atmosphere, and are cut into slabs or tablets of the required size. But it is preferred to use two parts of fine powdered baryta, and one part of albumen, well worked together, and rolled out into slabs. The best plan hitherto discovered for working the materials together, is that commonly used in the manufacture of Parian marble; this composition may also be used spread upon paper, if desired. These slabs or tablets are then carefully scraped, to give them a perfectly even surface. They are then washed with alcohol, to remove any impurity therefrom, and are prepared in the ordinary manner to receive positive pictures. The pictures having been printed, the entire slab or tablet may be immersed for a few minutes in a weak solution of nitro-sulphuric acid or nitro-hydrochloric acid, for the purpose of rendering the picture more clear and brilliant. It is then fixed in the usual manner with hypo-sulphite of soda, and is washed, and then dried on a marble or other slab, or under pressure, to prevent it from warping.

MISCELLANEOUS IMPROVEMENTS IN PHOTOGRAPHY.

Hallotypes. — The following is a description of a patent recently granted to J. Bishop Hall, of New York City, for a peculiar method of treating pictures to produce a high degree of artistic and stereoscopic effect of objects, applicable to photographs, engravings, lithographs, and similar pictures. The principle of the invention consists in combining two or more photo-

graphic or other prints to form one picture. The pictures must be fac-similes or duplicate impressions, on semi-transparent material. If the invention is to be applied to photographs, let two copies be taken in the usual way, upon photographic paper. The paper of the two pictures is then rendered somewhat transparent by the application of oil to it. Each picture is then to be cemented to a separate plate of glass by means of copal or other suitable transparent varnish, which must be previously applied to the glass, and partially dried — attained to the state called *tacky*. In applying the picture to the glass, care must be taken to press out all the air bubbles between the paper and the glass. Each picture is then allowed to become dry, or nearly so, when it will be well to scrape off the back carefully to remove any excrescences. After this is accomplished, one or more coats of copal or other suitable varnish is applied to the pictures; when these are dry, the two plates of glass are joined together in such a manner that the lines of the pictures coincide, in which position they are cemented or framed together, and excluded from the atmosphere.

This is a description of the invention in its simplest form. Different effects may be produced when the front picture only is executed or attached to the plate of glass, and the second one placed some distance behind it so as to correspond with the other. Fine effects are produced by cutting out certain parts of the back picture, thus allowing more light to pass to the front one. Colors may be applied to the back picture only or partially to the two, so that one color on the front picture may have a ground of another color. A back-ground of white light, or reflecting material, placed behind the pictures, such as enamelled white paper or a plate of enamelled white china, produces good effects. The back-ground may also be silvered over to produce effects according to the taste of the operator.

Pictures produced according to this process are called *Hallotypes*. They have an appearance something like wax figures, but on the whole are artistic and beautiful. — *Scientific American.*

A method has recently been devised by Mr. Gill, of Liverpool, by which a stereoscopic photograph can be taken with a single lens, and with an ordinary camera. The observer looks into two mirrors jointed in the centre, raised at each side so as to reflect two figures, and these being opposite the lens, two pictures are taken with one lens. But not only are the two pictures taken at one sitting, but they are non-inverted, which is also a great advantage obtained by the discovery.

Transparent Enamel Photographs. — A novel and elegant adaptation of the photographic art has recently been brought out in London, and patented under the name of "Transparent Enamel Photographs."

Transparency is attained by fixing sheets of enamel upon glass surfaces, the two forming one plate. Upon one enamel face the picture is taken, the surface having been rendered sensitive by ordinary processes. Then, when inverted, the glass becomes a ready-made protection for the pictures on one side, and another sheet of glass may be placed at the back or not, at pleasure. The enamel surface will also take water-colors, and when thus painted, the effect is scarcely inferior to that of ivory. These colors are

afterwards fixed by a peculiar process, which is one of the secrets of the invention. The advantages thus secured are transparency, capability of being perfectly cleansed, and, as it is confidently stated, durability of colors. The purity and delicacy of the result may be well imagined, and will doubtless bring the discovery into use for ornamental windows, lamp-shades, and all other transparencies. It will be valuable also for illuminations, and is quite available for stereoscopic views. The ground of the picture is, of course, a pure and perferct white, and this, though in some respects an advantage and a desideratum, has its drawbacks in producing, artistically speaking, too great contrasts of black and white. Want of tone is the defect of these pictures, but in everything else the effect is all that can be desired. The patentee also proposes the application of his process for manufacturing purposes. He says, "It can be applied to the production of clock and chronometer dials, watch dials, thermometers, barometers, compass faces, and tablets of *every description*, ensuring a degree of accuracy never yet attained by the engraver. They can be produced at less than one-third the cost of the materials at present in use for the above purposes, and far excel in appearance anything ever yet attempted. It cannot be injured by any length of time or atmospheric changes, and can be washed as an ordinary piece of porcelain."

Curious Photographic Results. — At the Dublin meeting of the British Association, M. L'Abbe Moigno presented, in the name of M. Bertsch, microscopic photographs ; in the name of M. Neiper de St. Victor, a perfectly new method of exhibiting, by means of photography, the phosphorescence and fluorescence of bodies ; and in the name of M. Bingham, improved photographic copies of oil paintings.

Photographic Fac-similes of Ancient Manuscripts. — The powers of photography have very recently been employed with great success in producing a number of fac-simile copies of the Codex Argenteus of Ulphilas, the oldest (fourth century) sample extant of the Gothic language, the great mother-tongue of the whole German stock. Dr. Leo, a gentleman connected with the Royal Library in Berlin, was led by the numerous variations in the different reprints of the Ulphilas texts, to travel to Upsala, where the MS. is still preserved, and there take photographic pictures on glass (so called negatives) of about sixty pages, containing disputed texts. His original idea was simply that of obtaining a fac-simile for convenient study at home ; but the process itself has gone a great way to solve the difficulties and disputes, by showing clearly what forms part of the original manuscript, and what has been written in or over it subsequently. The success of this application of photography, will, perhaps, incite the curators of our valuable libraries to publish fac-simile editions of rare MSS. for the benefit of the distant student, and submit all palimpsests and other recondite parchments to this most detective test before proceeding to purchase.

Mr. Beckingham, a photographist of Birmingham, England, recently introduced a process which is a modification of two dry collodion processes, and combines the advantages of both gelatine and glycerine. He primarily prepares his plates with Ramsden's collodion in a slightly acid bath, and after

a good washing, a solution made by dissolving 180 grains of pure gelatine in twenty ounces of water, filtering whilst hot, and when nearly cold, adding three ounces of glycerine of specific gravity 1.3000, is poured upon the plate for a few seconds, and the plate is then dried. Plates prepared in this way have been kept for thirty-eight days without producing any diminution of sensitiveness. Previous to developing, the plate is immersed in cold water for five minutes, the development being accomplished either with gallic acid and nitrate of silver, or pyrogallic acid.

Newell's Photographic Portraits.—A new invention by Mr. Newell, of Philadelphia, consists in crystallizing a photograph or other picture on paper, and securing the photograph thus prepared between two plates of glass by a transparent cement, which renders the whole impervious to air or dampness, securing durability in any climate. The coloring is then applied, which, being transmitted through this transparent medium, produces the peculiar softness and natural appearance of texture, while it preserves every line, expression, and feature precisely as taken by the camera. The whole effect is to produce a picture more exact in tints, shadows, and colors, and more perfect in its minutest details, than has heretofore been obtained; at the same time there is a roundness and stereoscopic appearance which no other picture possesses without the aid of the stereoscope itself.

Crayon Photographs. — The shading of the so-called Crayon photographs, invented by Mr. Mayall of London, and called Crayon, from their close resemblance to crayon drawings, is effected by means of a revolving disc in which the opening is in the form of a small star. This is interposed between the object, or sitter, and the camera; and the central portion of the star is made large enough to admit the rays from that part of the object which is to be shown in strong light, whilst the rays from those parts which are to be gradually shaded off to a dark background, are partially intercepted by the points of the star

DRY COLLODION PROCESSES.

Mr. G. R. Berry has recently published in the Chemist the following resume of the various dry collodion processes now in use in photography:

We will take first the ordinary collodion process, which is thus divided:

1. Preparation of the collodion.
2. Preparation of the nitrate of silver bath.
3. Preparation of the developing solution — positive and negative.
4. Removal of the surplus chemicals.
5. Varnishing.

Collodion is, as all are aware, a solution of one of the pyroxyline compounds, in a mixture of alcohol and ether, and holding also in solution an iodide, or a mixture of iodide and bromide of potassium, ammonium, cadmium, or other bases. The number of these is not very extensive, as the case will admit only those soluble in the menstruum before mentioned, but if the ingredients are few in number, the variations in quantity and relative adjustment are almost infinite, as every photographer has his series of pet fancies, and to this fact nearly all the disheartening failures of amateurs are

attributable, and almost every instance of success has been attained by those who, adopting one formula, have adjusted their silver bath and developer in accordance; and, therefore, when the impressions fail to be successful, have only these three items to examine or replace. The silver bath varies in its strength from twenty to sixty grains per ounce of water, and it is on the proper reaction between the collodionized plate and the nitrate of silver in solution all success depends. The most approved formula for the silver bath for the negative and dry processes I believe to be the following:

Nitrate of silver, that has been fused and probably containing a portion of nitrite,. ....1 ounce.
Dissolve in 4 oz. water, to which must be added iodide of potassium,.......20 grains.

This mixture must be well agitated at intervals for one hour. By this means the strong solution of nitrate of silver dissolves a portion of the precipitated iodide, and lets fall another portion on the addition of water to make up fourteen fluid ounces. The solution is then filtered and is ready for use. The collodion plates used will present an even primrose-colored surface, without *striæ* or other markings, and the developed impressions will be clear and free from any irregularity of coating. The collodion process negative has, in itself, many advantages. Its great advantage is — exquisite sensibility, inasmuch as under favorable circumstances instantaneous impressions may be obtained; at the same time the delicacy of definition is all that can be desired, and if not equal to albumen, it is the fault in the preparation of the pyroxyline from which the collodion is made. It is facile in manipulation and speedy in its perfected results. Its disadvantage is the necessity of obtaining the impressions in the camera in the first few minutes from the excitation of the plate; it is therefore impossible to work far away from the dark closet or the tent in which the plates are prepared and developed. It is this that has prompted experimenters to devise some plan by which the sensitiveness of the plate might be indefinitely prolonged, and I lay before you the various plans proposed, in the order of their publication, as correctly as my means will allow.

If we excite a collodion plate in the usual way, and leave it in the dark slide until dry, we shall find that the nitrate of silver film, as it concentrates by evaporation, dissolves out the iodide from the collodion surface, and eventually crystallizes in minute stellar groups, completely destroying the utility of the surface as a photographic medium. The prevention of this result was the first problem to be solved if the plates were to be preserved any length of time after preparation. At first various plans were tried to prevent the evaporation altogether, as, for instance, laying a second glass plate directly upon the collodionized surface. Thus Messrs. Spiller and Crooks attempted the same object by steeping the prepared plate in a strong solution of a deliquescent nitrate. At first zinc, and subsequently magnesia, were employed. At a later period, Messrs. Shadbolt and Lyte partially washed off the excess of nitrate of silver from the plate, and poured over it a solution of honey, and I do not think there is, even now, a better process extant.

Simple oxymel, glycerine, treacle, and various other substances have also been employed. During this period the somewhat remarkable process of M. Taupenot was published, and was as follows : The plate was first coated with collodion and sensitized in the usual way, the surface washed, and mixture of albumen and honey slightly iodized was poured over it ; it was then allowed to dry, and again plunged into the silver bath and rinsed, when it might be used, either wet or dry. The theory of the process, at the time it came out, was imperfectly understood ; and, as it involved very operose manipulations, it was not so generally used as it deserved. The main point was the coating the excited collodion surface with the albumen, thus filling its pores and preserving it in some measure from the action of the air ; and it being ascertained that even if the whole of the free nitrate were removed by washing, and the plate dried in the dark chamber, it was yet sensitive, although in an inferior degree than when recently prepared.

Dr. Hill Norris proposed to cover the washed plates with gelatine, and I believe his dried plates preserve their sensibility for many months.

Mr. Sparling employed a solution of dextrine mixed with honey, and iodized in the same way as Taupenot, also following him in two immersions in the silver bath.

Mr. Maxwell Lyte has yet more recently advocated the use of what he terms *meta-gelatine,* produced by boiling a solution of gelatine with sulphuric acid until it ceases to gelatinize on cooling, then removing the acid by digestion upon carbonate of lime, filtering, and adding a portion of clarified honey. This is poured over the plate, without previously washing, and stored away until required for use. This is certainly the quickest, and, as far as I have seen it tried, the most satisfactory process, as it may be used indifferently, either wet or dry.

SIMPLE METHOD OF DETECTING COUNTERFEIT PHOTOGRAPHIC BANK BILLS.

In most cases, a photographic counterfeit bank note may be detected by the following simple experiment :

Procure a half ounce of fluid of the solution of Cyanide of potassium — which may be procured at any respectable drug store. With a drop or two of this liquid, moisten any part of the suspected bill, and if it be a photograph bill the color will in two or three minutes be changed or removed. If the bill be genuine — that is, no photograph — it will produce no change upon its color or face.

ON A MOVABLE HORIZONTAL SUN-DIAL, WHICH SHOWS CORRECT SOLAR TIME WITHIN A FRACTION OF A MINUTE.

In a communication on the above subject, read to the British Association, Dublin, by M. Donovan, the author first gave a short account of common horizontal dials, showing that, in consequence of the penumbral shadow of the gnomon, they could scarcely ever give the time within three minutes, even when they were well constructed and carefully set. He then explained

his own dial, which, though large, was portable, with means of setting it in the meridian and truly horizontally, which he explained. The circle of the dial was about thirteen inches diameter; towards its south point a fine needle rose, from which two human hairs proceeded, one in a fixed position, parallel to the earth's axis at the place; this was supported by a stout brass arch, which could be shortened or lengthened, and which had a fine slit at its upper part to hold the fixed hair. The shadow of this hair the author stated was always sharp and well-defined for about three inches from the needle, round which a small hour-circle of about that diameter was graduated. The floating hair, as the author called it, being taken by the hand and laid along the shadow of the fixed hair so as to bisect it where it was sharp, was stretched out to an outer graduated hour-circle, where the induction could be easily read off to a fraction of a minute, amounting to a few seconds.

NEW TELESCOPE FOR THE PARIS OBSERVATORY.

A new telescope of the largest dimensions is now in the process of construction for the Paris Observatory. The objective of the telescope will be constructed with two discs of flint glass and crown glass, cast in the glass-house of Chauce & Co., Birmingham, England, which were on exhibition at the Crystal Palace in Paris. These glasses were imperfectly appreciated by the jury; for it was thought that after extracting certain portions that were not perfectly transparent and remelting them several times, they would not afford an objective over forty centimetres in diameter. They were, however, deemed irreproachable, and were purchased for 50,000 francs; and it is now expected that the objective made from them will leave a diameter of seventy-three centimetres. If the curvature obtained be perfect, the achromatism without fault, and the expected size be attained, France will have the most powerful lens in the world.

TELESCOPE STEREOSCOPES.

Mr. Jas. Elliot, in a communication to the Philosophical Magazine (London, Jan. 1857), states that he has recently succeeded in constructing what he believes to be a new form of the stereoscope. Its object is to unite *large* binocular photographic pictures in a different way from any that has hitherto been followed. The pictures are placed side by side, and viewed through two small telescopes, like those of opera-glasses, with the directions of their axes crossing each other; the left hand picture being viewed with the right eye, and the right-hand picture with the left eye. The two telescopes are connected together, the connecting apparatus being capable of two adjustments; one to suit the width of the eyes, and the other to give the obliquity required. When the instrument is placed on a stand, as I have it, two other adjustments are required; the first to bring the telescopes to the proper elevation, and the second to bring the plane of their axes into parallelism with the upper or lower margins of the pictures.

The instrument is constructed in such a way that these adjustments are

made with great facility; and when the pictures are united, the effect is excellent.

THE KALOTROPE.

Rev. T. Rose, of Glasgow, communicates to the London Athenæum the following description of a new instrument, an improvement on Prof. Quetetet's Thaumatrope, which he calls a "Kalotrope":

The kalotrope exhibits to an entire company the well-known illusions of the Thaumatrope, but its claims to be considered a perfectly new optical arrangement rest in a peculiarity of action by which a number of illusive changes are brought over any *one* disc of devices. The mechanical construction of the apparatus consists of two concentric wheels, to which a considerable range of velocity is given by a series of wheels and pulleys. They move in contrary directions — the one wheel (the hinder) carrying the disc of devices; and the front one carrying a disc with radial perforations, differing in number and character. To understand the effect, we must have regard to the angular motion of the perforations through which alone the devices can be seen. Now it is obvious, that if the devices were at rest, and the perforations only moved, the latter must pass over a space equal to the full breadth of the figures in order to clear them; but since the devices and perforations are both moving, and in contrary directions, the devices are narrowed in one of their diameters in proportion to the relative velocities of the wheels. But whilst the dimensions of the devices are measured to the eye be the relative motions of the wheels, their number is dependent solely on the number of perforations in the front disc. Hence arises an almost indefinite field of illusion, in the way of multiplication, combination, involution, and intricacy of motion. I have prepared an extensive series of discs to bring out these effects. The kalotrope is not, however, confined in its action to merely pleasing illusions; it likewise offers valuable scientific illustrations in regard to the intensity and duration of spectra, the measure of persistence, and certain remarkable properties of complementary color. I think the kalotrope is a device which may be recommended to the drawing-room for its beautiful effects, and may prove of value in the lecture-room as an exponent of scientific truth.

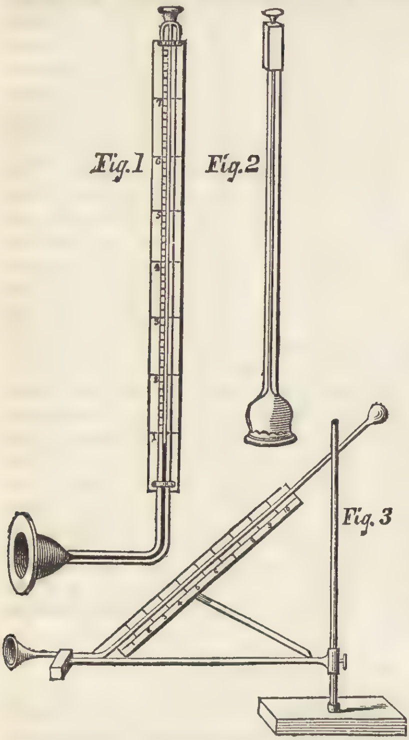
THE OPTHALMOSCOPE.

An instrument called the Ophthalmoscope, by the aid of which the human eye may be internally examined, has recently been brought to the notice of the scientific world. The instrument is in the form of a concave mirror, with a hole in the centre, in which a lens is inserted; to this another lens is added which, however, is separate and movable. When the instrument is used, a lighted candle is placed by the side of the patient. The concave mirror is then held in front of the eye to be examined, while the movable lens is suspended between the light and the mirror in such a manner as to concentrate the rays of the first on the second. The reflected rays converge on the retina, and on passing through it diverge and render luminous the whole interior of the eye, which the observer can see by looking through

the lens placed in the mirror's centre. The retina and the lens form a microscope, the multiplying power of which is about five hundred.

SPHYGMOSCOPE.

The above name has been given to an instrument invented by Dr. Scott Alison, of London, for indicating the movements of the heart and blood-vessels. It consists of a small chamber containing alcohol, or other liquid, provided with a thin India rubber wall, where it is to be applied to the chest. At the opposite extremity the chamber communicates with a glass tube, which rises to some height above its level — the chamber. Liquid is supplied to the instrument until it stands in the tube a little above the level of the chamber. The pressure of the column of liquid in the tube acts upon the elastic or yielding wall of India rubber, and causes it to protrude. This protruding part, or chest-piece, is very readily affected by external impulse ; it yields to the slightest touch, and, being pushed inwards, causes a displacement of this liquid in the non-elastic chamber, and forces a portion of the liquid up the tube. The protruding wall of India rubber is driven inwards when it is brought in contact with that portion of the chest which is struck by the apex of the heart, and a rise in the tube takes place. When the heart retires, the India rubber wall, affected by the pressure of the column of liquid in the tube, is pressed back, follows the chest, and permits the liquid to descend. The degree to which the India rubber wall is forced in by the tube, and the amount of protrusion of the India rubber wall which takes place when the heart retires is denoted by a corresponding fall in the tube. The tube is supplied with a graduated scale, to denote the rise and fall with exactitude. The glass tube is provided at the top with a brass screw and collar, to prevent the egress of the liquid when the instrument is not in use, or a bulb



with an orifice may be supplied. When employed, the glass tube is left open to permit of the passage of the air to and fro.

Figure 1 represents an instrument without a stand; figure 2 is another form of it without a stand; and figure 3 is the most perfect form, but is not quite so convenient.

The glass tube is a foot or more long, and the round bore is about the one-eighth part of an inch. If the bore be much larger, the movement will be inconsiderable; if much less, capillary attraction will interfere and prevent free motion.

When the instrument (fig. 3.) is to be employed, mounted upon its stand, it is placed upon a firm table with the chamber projecting beyond it. The person whose heart is to be examined is seated upon a firm chair, with his chest erect and free from motion. The protruding India rubber wall of the chamber, or chest-piece, is delicately made to receive the blow of the apex of the heart. The liquid in the tube is now observed to be in motion. With persons in ordinary health, the liquid rises and falls about an inch. This rise and fall, after taking place three or four times, is followed by a much longer rise and fall to the extent of three or four inches, due to the advancement and retirement of the wall of the chest during the acts of respiration. The shorter rise and fall are again repeated, and are again followed by the longer rise and fall caused by the motions of the chest. During the longer rise and fall due to respiration, the beat and retreat of the heart are still to be recognized by brief interruptions in the rise and fall of the liquid. Thin persons are very favorable for examination; on the other hand, the corpulent, less readily affect the instrument. Placed upon the heart, it indicates strokes of that organ which are so feeble as to have no corresponding pulse at the wrist.

No pause whatever in the movement of the liquid has been at any time observed when the sphygmoscope has been carefully placed so as to receive the full beat, and fall back with freedom. This would go to show that the heart, however slow, is in constant motion, and, contrary to the belief of many physiologists, enjoys no pause. There is no pause in the descent of the liquid, which takes place when the heart retires from the thoracic walls, in the middle of which movement, it has been said, a very short pause is to be observed in living animals having the heart exposed.

When the heart is excited, the liquid in the sphygmoscope rises and falls more than usual; but the rise and fall of the excited enlarged heart is much the same as the rise and fall of the excited normal organ. For the most part, the enlarged heart gives movements to the instrument when placed upon the ribs and sternum, whilst the normally-sized heart affects it more exclusively when it is placed upon the fifth intercostal space.

The sphygmoscope indicates with exactitude both the absolute and the comparative influences upon the heart, of food, cordials, stimulants, and tonic medicines. It does the same in respect to depressing causes, such as hunger, cold, and sedatives. With the aid of this instrument the fact is demonstrated that the action of the heart may be great when the pulse is small, that the heart may strike the instrument with force when the pulse scarcely affects

the liquid of the hand sphygmoscope. It affords proof that the pulse is one thing, and the heart's action another, and teaches that the pulse is only an approximate sign of the state of the heart. It is found also, that while cold at the surface and extremities may depress the pulse, the heart may remain little enfeebled, or even become excited, and that warmth and friction applied to the extremities may cause an excited pulse without there being any accompanying increased force of the heart.

The sphygmoscope (fig. 2,) having a level elastic wall instead of a protruding one, and having a glass tube with an almost capillary bore, forms a remarkably delicate indicator of the pulse. It is so delicate in its impressions that it is appreciably affected by the regurgutant wave in the jugular veins, and by the wave in arteries much smaller than the radial. From its nicety in manifesting the beat of the blood-wave, it is very valuable.

By means of this hand instrument applied to the arteries a comparison is readily made between the time of the beat of the heart and the rise of the arteries under the influence of the blood-wave. This instrument is much more delicate than the finger in such an inquiry. The impressions made upon the fingers of two hands fail to be conveyed with sufficient nicety to the mind to tell with certainty the relative time of the beat of the heart and arteries. Except in cases of extreme slowness, the sensations obtained from the two hands impressed at nearly the same time, do not admit of a distinct difference in respect to time being made out. It has been to this very defect the erroneous idea, that the beat of the heart and the beat of the pulse are synchronous, or nearly so, owes its origin and continuance.

The hand sphygmoscope placed upon the radial artery, shows a rise of the liquid while there is a fall in the sphygmoscope placed over the heart. As the liquid in the one instrument starts from below, the liquid in the other starts from above, and as the liquid in the one reaches the top of its ascent, the liquid in the other reaches the bottom of its descent, to renew their opposing course. The movements in the two instruments at the same instant are always opposed, and the whole time occupied in the movement of one instrument in one direction appears to be occupied by the movement of the other in the opposite direction. The movements *alternate* with as much apparent exactitude as the arms of a well-adjusted balance. When the lapse of time between the beat of the heart and the pulse at the wrist was first observed, suspicion of disease of the aorta was entertained, but the subsequent examination of many persons proved that this alternation was natural. In some twenty persons, subjected to examination, the complete alternation has been made out without the shadow of a doubt. These persons were of all ages above childhood, and had the pulse of different degrees of rapidity, from 60 to 100.

Hand sphygmoscopes placed upon the carotid, the barachial, the radial, the femoral, and the dorsal artery of the foot, rise at the same instant, and fall at the same point of time.

These facts prove the existence of two great laws not previously enunciated — first, that the heart's beat alternates with the pulse at the wrist;

secondly, that the pulse of arteries beyond the chest takes place in all parts at the same instant, and without any appreciable interval.

The sphygmoscope forms a good pneumoscope. It delicately measures the rise and fall of the chest in respiration. It likewise declares the relative duration of inspiration and expiration, and may thus prove useful in the detection of incipient phthisis, and other pulmonary diseases. When the liquid has attained its highest elevation at the end of inspiration, it immediately begins to fall; but when it has reached the lowest point at the end of expiration it remains there some instants. The ascent is slower than the descent. After the fall of an ordinary expiration, a forced expiration gives a second fall.

The sphygmoscope (fig. 1,) may be employed without a stand, and is then more portable; but from the want of a fixed basis, and from the motion of the ribs on which it must rest, its manifestations are less extensive and satisfactory. When employed without a stand, as it must rest upon the ribs, the elastic wall of the chamber should be plain, and not protruding.

ON THE SOUNDS PRODUCED BY THE COMBUSTION OF GASES IN TUBES.

Professor John Tyndall, in a communication to the London Journal of Gas Lighting, on the above subject, after reviewing the various theories entertained at different periods, — proceeds to say: — In 1818, Mr. Faraday took up the subject, and showed that the tones were produced when the glass tube was enveloped by an atmosphere higher in temperature than 212° Fahr. That they were not due to aqueous vapor, was further shown by the fact that they could be produced by the combustion of carbonic oxide. He referred the sounds to successive explosions produced by the periodic combination of the atmospheric oxygen with the issuing jet of hydrogen gas. This is undoubtedly the true source of the sounds.

I am not aware that the dependence of the pitch of the note on the size of the flame has as yet been noticed. To this point I will, in the first place, briefly direct attention.

A tube twenty-five inches long was placed over an ignited jet of hydrogen: the sound produced was the fundamental note of the tube.

A tube twelve and a half inches long was brought over the same flame, but no sound was obtained.

The flame was lowered, so as to make it as small as possible, and the tube last mentioned was again brought over it; it gave a clear melodious note, which was the octave of that obtained with the twenty-five inch tube.

The twenty-five inch tube was now brought over the same flame; it no longer gave its fundamental note, but exactly the same note as that obtained from the tube of half its length.

Thus we see, that although the speed with which the explosions succeed each other depends upon the length of the tube, the flame has also a voice in the matter: that to produce a musical sound, its size must be such as to

enable it to explode in unison either with the fundamental pulses of the tube, or with the pulses of its harmonic divisions.

With a tube six feet nine inches long, by varying the size of the flame, and adjusting the depth to which it reached within the tube, I have obtained a series of notes in the ratio of the numbers 1, 2, 3, 4, 5.

These experiments explain the capricious nature of the sounds sometimes obtained by lecturers upon this subject. It is, however, always possible to render the sounds clear and sweet, by suitably adjusting the size of the flame to the length of the tube.*

Since the experiments of Mr. Faraday, nothing, that I am aware of, has been added to this subject, until quite recently. In a recent number of Poggendorff's "*Annalen,*" an interesting experiment is described by M. Schaffgotsch, and made the subject of some remarks by Professor Poggendorff himself. A musical note was obtained with a jet of ordinary coal gas, and it was found that when the voice was pitched to the same note, the flame assumed a lively motion, which could be augmented until the flame was actually extinguished. M. Schaffgotsch does not describe the conditions necessary to the success of his experiment; and it was while endeavoring to find out these conditions that I alighted upon the facts which form the principal subject of this brief notice. I may remark that M. Schaffgotsch's result may be produced, with certainty, if the gas be caused to issue under sufficient pressure through a very small orifice.

In the first experiments I made use of a tapering brass jet, ten and a half inches long, and having a superior orifice about one-twentieth of an inch in diameter. The shaking of the singing flame, within the glass tube, when the voice was properly pitched, was so manifest as to be seen by several hundred people at once.

I placed a syrene within a few feet of the singing flame, and gradually heightened the note produced by the instrument. As the sounds of the flame and syrene approached perfect unison, the flame shook, jumping up and down within the tube. The interval between the jumps became greater, until the unison was perfect, when the motion ceased for an instant; the syrene still increasing in pitch, the motion of the flame again appeared, the jumpings became quicker and quicker, until finally it escaped cognizance by the eye.

This experiment showed that the jumping of the flame, observed by M. Schaffgotsch, is the optical expression of the *beats* which occur at each side of the perfect unison; the beats could be heard in exact accordance with the shortening and lengthening of the flame. Beyond the region of these beats, in both directions, the sound of the syrene produced no visible motion of the flame. What is true of the syrene is true of the voice.

While repeating and varying these experiments, I once had a silent flame within a tube, and on pitching my voice to the note of the tube, the flame, to

* With a tube fourteen and a half inches in length and an exceedingly minute jet of gas, I obtained, without altering the quantity of gas, a note and its octave; the flame possessed the power of changing its own dimensions to suit both notes.

my great surprise, instantly started into song. Placing the finger on the end of the tube, and silencing the melody, on repeating the experiment, the same result was obtained.

I placed the syrene near the flame, as before. The latter was burning tranquilly within its tube. Ascending gradually from the lowest notes of the instrument, at the moment when the sound of the syrene reached the pitch of the tube which surrounded the gas flame, the latter suddenly stretched itself and commenced its song, which continued indefinitely after the syrene had ceased to sound.

With the jet which I have described, and a glass tube, twelve inches long, and from one-half to three-fourths of an inch internal diameter, this result can be obtained with ease and certainty. If the voice be thrown a little higher or lower than the note due to the tube, no visible effect is produced upon the flame: the pitch of the voice must lie within the region of the audible beats.

By varying the length of the tube we vary the note produced, and the voice must be modified accordingly.

That the shaking of the flame, to which I have already referred, proceeds in exact accordance with the beats, is beautifully shown by a tuning-fork which gives the same note as the flame. Loading the fork so as to throw it slightly out of unison with the flame, when the former is sounded and brought near the flame, the jumpings are seen at exactly the same intervals as those in which the beats are heard. When the tuning-fork is brought over a resonant jar or bottle, the beats may be heard and the jumpings seen by a thousand people at once. By changing the load upon the tuning-fork, or by slightly altering the size of the flame, the quickness with which the beats succeed each other may be changed, but in all cases the jumpings address the eye at the same moment that the beats address the ear.

With the tuning-fork I have obtained the same results as with the voice and syrene. Holding a fork over a tube which responds to it, and which contains within it a silent flame of gas, the latter immediately starts into song. I have obtained this result with a series of tubes varying from ten and a half to twenty-nine inches in length. The following experiment could be made. A series of tubes, capable of producing the notes of the gamut, might be placed over suitable jets of gas; all being silent, let the gamut be run over by a musician with an instrument sufficiently powerful, placed at a distance of twenty or thirty yards. At the sound of each particular note, the gas-jet contained in the corresponding tube would instantly start into song.

I must remark, however, that with the jet which I have used, the experiment is most easily made with a tube about eleven or twelve inches long; with longer tubes it is more difficult to prevent the flame from singing spontaneously, that is, without external excitation.

The principal point to be attended to is this. With a tube, say of twelve inches in length, the flame requires to occupy a certain position in the tube in order that it shall sing with a maximum intensity. Let the tube be raised, so that the flame may penetrate it to a less extent; the energy of the sound will be thereby diminished, and a point (A), will at length be attained

where it will cease altogether. Above this point, for a certain distance, the flame may be caused to burn tranquilly and silently for any length of time, but when excited by the voice it will sing.

When the flame is too near the point (A), on being excited by the voice or by a tuning-fork, it will respond for a short time, and then cease. A little above the point where this cessation occurs, the flame burns tranquilly, if unexcited, but if once caused to sing it will continue to sing. With such a flame, which is not too sensitive to external impressions, I have been able *to reverse the effect hitherto described*, and to stop the song at pleasure by the sound of my voice, or by a tuning-fork, without quenching the flame itself. Such a flame I find may be made to obey the word of command, and to sing or cease to sing as the experimenter pleases.

The mere clapping of the hands, producing an explosion, shouting at an incorrect pitch, shaking of the tube surrounding the flame, are, when the arrangements are properly made, ineffectual. Each of these modes of disturbance doubtless affects the flame, but the impulses do not accumulate, as in the case where the note of the tube itself is struck. It appears as if the flame were *deaf* to a single impulse, as the tympanum would probably be, and, like the latter, needs the accumulation of impulses to give it sufficient motion. A difference of half a tone between two tuning-forks is sufficient to cause one of these to set the flame singing, while the other is powerless to produce this effect.

I have said that the voice must be pitched to the note of the tube which surrounds the flame; it would be more correct to say the note produced by the flame when singing. In all cases, this note is sensibly higher than that due to the open tube which surrounds the flame; this ought to be the case, because of the high temperature of the vibrating column. An open tube, for example, which, when a tuning-fork is held over its end, gives a maximum reinforcement, produces, when surrounding a single flame, a note higher than that of the fork. To obtain the latter note, the tube must be sensibly longer.

What is the constitution of the flame of gas while it produces musical sounds? This is the next question to which I will briefly call attention. Looked at with the naked eye, the sounding flame appears constant; but is the constancy real? Supposing each pulse to be accompanied by a physical change of the flame, such a change would not be perceptible to the naked eye, on account of the velocity with which the pulses succeed each other. The light of the flame would appear continuous on the same principle that the troubled portion of a descending liquid jet appears continuous, although by proper means this portion of a jet can be shown to be composed of isolated drops. If we cause the image of the flame to pass speedily over different portions of the retina, the changes accompanying the periodic impulses will manifest themselves in the character of the image thus traced.

I took a glass tube, three feet two inches long, and about an inch and a half in internal diameter, and, placing it over a very small flame of olefiant gas (common gas will also answer), obtained the fundamental note of the tube. On moving the head to and fro, the image of the sounding flame was

separated into a series of distinct images; the distance between the images depended upon the velocity with which the head was moved. This experiment is suited to a darkened lecture-room. It was still easier to obtain the separation of the images in this way, when a tube six feet nine inches in length and a larger flame were made use of.

As suggested to me by a lady to whom I had the pleasure of showing these experiments, the same result is obtained when an opera-glass is moved to and fro before the eye.

But the most convenient mode of observing the flame is with a mirror; and it can be seen either directly in the mirror, or by projection upon a screen.

A lens of thirty-three centimeters focus was placed in front of a flame of common gas, upwards of an inch long, and a paper screen was hung at about six or eight feet distance behind the flame. In front of the lens a small looking-glass was held, which received the light that had passed through the lens, and reflected it back upon the screen placed behind the latter. By adjusting the position of the lens, a well defined inverted image of the flame was obtained upon the screen. On moving the mirror the image was displaced; and, owing to the retention of the impression by the retina, when the movement was sufficiently speedy, the image described a continuous luminous track. Holding the mirror still, the six foot nine inch tube was placed over the flame; the latter changed its shape the moment it commenced to sound, remaining, however, well defined upon the screen. On now moving the mirror, a totally different effect was produced; instead of a continuous track of light, a series of distinct images of the sounding flame was observed. The distance of these images apart varied with the motion of the mirror; and, of course, could be made, by suitably turning the reflector, to form a ring of images. The experiment is beautiful, and in a dark room may be made visible to a large audience.

The experiment was also varied in the following manner: — A triangular prism of wood had its sides coated with rectangular pieces of looking-glass; it was suspended by a thread, with its axis vertical; torsion was imparted to the thread, and the prism acted upon by this torsion caused to rotate. It was so placed that its three faces received in succession the beam of light sent from the flame through the lens in front of it, and through the images upon the screen. On commencing its motion, the images were but slightly separated, but became more and more so as the motion approached its maximum. This once past, the images drew closer together again, until they ended in a kind of luminous ripple. Allowing the acquired torsion to act, the same series of effects could be produced, the motion being in an opposite direction. In these experiments, that half of the tube which was turned towards the screen was coated with lampblack, so as to cut off the direct light of the jet from the screen.

But what is the state of the flame in the interval between two images? The flame of common gas or of olefiant gas, owes its luminousness to the solid particles of carbon discharged into it. If we blow against a luminous gas flame, a sound is heard, a small explosion in fact, and by such a puff

the luminousness may be caused to disappear. During a windy night the exposed gas-jets in the shops are often deprived of their light and burn blue. In like manner the common blowpipe jet deprives burning coal gas of its brilliant light. I hence concluded that the explosions, the repetition of which produces the musical sound in the case before us, rendered, at the moment they occurred, the combustion so perfect as to extinguish the solid carbon particles; but I imagined that the images on the screen would, on closer examination, be found united by spaces of blue, which, owing to their dimness, were not seen by the method of projection. This, in many instances, was found to be the case.

I was not, however, prepared for the following result:— A flame of olefiant gas, rendered almost as small as it could be, was procured. The three feet two inch tube was placed over it; the flame on singing became elongated and lost some of its light, still it was bright at its top; looked at in the moving mirror, a beaded line of great beauty was observed; in front of each bead was a little luminous star; after it, and continuous with it, a spot of rich blue light, which terminated and left, as far as I could judge, a perfectly dark space between it and the next following luminous star. I shall examine this further when time permits me; but, as far as I can at present judge, the flame was actually extinguished and re-lighted in accordance with the sonorous pulsations.

When a silent flame, capable, however, of being excited by the voice in the manner already described, is placed within a tube, and the continuous line of light produced by it in the moving mirror is observed, I know no experiment more pretty than the resolution of this line into a string of richly luminous pearls at the instant when the voice is pitched to the proper note. This may be done at a considerable distance from the jet, and with the back turned towards it.

The change produced in the line of beads when a tuning-fork, capable of giving beats with the flame, is brought over the tube, or over a resonant jar near it, is also extremely interesting to observe. I will not at present enter into a more minute description of these results. Sufficient, I trust, has been said to induce experimenters to produce the effects for themselves; the sight of them will give more pleasure than any description of mine could possibly do.

ON THE OPTICAL STUDY OF VIBRATIONS.

A memoir has been recently presented to the French Academy, by M. Lissaijous "on the Optical Study of Vibrations." The author proposes, in judging of the number of vibrations which occasion particular sounds, to reject all appeals to the ear, and to judge of the vibratory motions by the eye. He places on the exterior face of a tuning-fork a small mirror, and directs a sun-beam upon it, which is reflected upon a paper screen placed in the angle of its reflection; the beam is concentrated by a convergent lens. As long as the tuning-fork is silent the image is motionless, but if it is vibrated the reflected ray vibrates in the same plane, and its extremity, rapidly oscillating on the screen, traces a lengthened image, whose superficies is in

proportion to the amplitude of the vibratory motion and to the square of the intensity of the sound furnished. A deaf man may consequently ascertain whether the sound exists, or whether it increases, or whether it dies away, and follow the variations of the figure described by the reflected ray. Nor is this all. Does the experiment-maker desire to know if this tuning-fork is in accord with another tuning-fork, he places a second mirror upon this new tuning-fork, and it is placed upon the angle of reflection of the first, taking care that both planes of vibration shall be perpendicular to each other; the reflected ray will again be thrown upon the screen. If each of the tuning-forks be vibrated singly, the luminous image will be lengthened; if the first tuning-fork produces a vertical extension, the second will produce a horizontal extension, and when both of them vibrate together, the experiment-maker will have at every instant the figure which results from the combination, or from two rectangular motions. He demonstrates that the figure under these circumstances must be either a circle or a straight line, or some one of the intermediate ellipses. The characteristic by which it may be discovered whether the two tuning-forks vibrate in unison, is that the figure, whatever it may be, remains permanent and like itself, although gradually diminishing by the progressive weakness of the initial movement. If on the contrary there is some difference between the two velocities of vibration, warning will be given of their existence by the deformation of the optical figure. In this way the eye will perceive differences which the most sensitive ear could not detect. If, instead of being in unison, the tuning-forks are in the octave, the optical figure becomes a sort of 8, which may change into a figure like the summit of a parabola; and here, too, the constancy of the change of the figure indicates that the octave is more or less just. All the musical intervals represented by the commensurable relations of the number of vibrations have their curves in which the two terms of the fraction are joined, written in geometrical language. Mirrors are not absolutely necessary to the application of this method, which consists in amplifying by optical means and composing together the vibratory motions of two bodies which are to be compared, so as to obtain without appealing to the ear a degree of precision which has no limit, except the irregularities of the mechanical phenomenon, or its too rapid duration.

ON THE EFFECT OF WIND ON THE INTENSITY OF SOUND.

The following is an abstract of a paper on the above subject, presented at the British Association, Dublin, by Prof. Stokes: —

The remarkable diminution in the intensity of sound, which is produced when a strong wind blows in a direction from the observer towards the source of sound, is familiar to everybody, but has not hitherto been explained, so far as the author is aware. At first sight we might be disposed to attribute it merely to the increase in the radius of the sound-wave which reaches the observer. The whole mass of air being supposed to be carried uniformly along, the time which the sound would take to reach the observer, and consequently the radius of the sound-wave would be increased by the wind in

the ratio of the velocity of sound to the sum of the velocities of sound and of the wind, and the intensity would be diminished in the inverse duplicate ratio. But the effect is much too great to be attributable to this cause. It would be a strong wind whose velocity was a twenty-fourth part of that of sound; yet even in this case the intensity would be diminished by only about a twelfth part. The first volume of the "Annales de Chimie," (1816), contains a paper by M. Delaroche, giving the results of some experiments made on this subject. It appeared from the experiments, First, that at small distances the wind has hardly any perceptible effect, the sound being propagated almost equally well in a direction contrary to the wind and in the direction of the wind; Secondly, that the disparity between the intensity of the sound propagated in these two directions becomes proportionally greater and greater as the distance increases; Thirdly, that sound is propagated rather better in a direction perpendicular to the wind than even in the direction of the wind. The explanation offered by the author of the present communication is as follows. If we imagine the whole mass of air in the neighborhood of the source of disturbance divided into horizontal strata, these strata do not all move with the same velocity. The lower strata are retarded by friction against the earth, and by the various obstacles they meet with; the upper by friction against the lower, and so on. Hence the velocity increases from the ground upwards, conformably with observation. This difference of velocity disturbs the spherical form of the sound-wave, tending to make it somewhat of the form of an ellipsoid, the section of which by a vertical diametral plane parallel to the direction of the wind is an ellipse meeting the ground at an obtuse angle on the side towards which the wind is blowing, and an acute angle on the opposite side. Now, sound tends to propagate itself in a direction perpendicular to the sound-wave; and if a portion of the wave is intercepted by an obstacle of large size, the space behind is left in a sort of sound-shadow, and the only sound there heard is what diverges from the general wave after passing the obstacle. Hence, near the earth, in a direction contrary to the wind, the sound continually tends to be propagated upwards, and consequently there is a continual tendency for an observer in that direction to be left in a sort of sound-shadow. Hence, at a sufficient distance, the sound ought to be very much enfeebled; but near the source of disturbance this cause has not yet had time to operate, and therefore the wind produces no sensible effect, except what arises from the augmentation in the radius of the sound-wave, and this is too small to be perceptible. In the contrary direction, — that is, in the direction towards which the wind is blowing, — the sound tends to propagate itself downwards, and to be reflected from the surface of the earth; and both the direct and reflected waves contribute to the effect perceived. The two waves assist each other so much the better as the angle between them is less, and this angle vanishes in a direction perpendicular to the wind. Hence, in the latter direction the sound ought to be propagated a little better than even in the direction of the wind, which agrees with the experiments of M. Delaroche. Thus the effect is referred to two known causes, — the increased velocity of the air in ascending, and the diffraction of sound.

ON A NEW AND SINGULAR ACOUSTIC PHENOMENA.

At the Dublin meeting of the British Association, Mr. Donovan, in a communication, first explained the beats which are experienced when two strings tuned nearly, but not exactly, to unison, are struck at the same time. He then stated that the Earl Stanhope had observed that when a tuning fork whilst vibrating was held to the teeth, similar beats were heard, which he, Earl Stanhope, attributed in the two prongs of the tuning fork not being in exact unison. This effect the author often tried to experience, but never could succeed until upon one occasion, just after he had ceased from violent exercise, having applied the fork to his teeth, he distinctly heard the beats. He was thus led to the true origin of the phenomenon, which he could now experience whenever he wished by running a short distance, particularly up and down stairs. The effect was caused by the beatings of his own heart, or the pulsations of the circulating blood. Some authorities however, would explain the phenomenon described by the author, to one set of vibrations propagated to the auditory nerve through the bones of the teeth, and of the head, modified by the action of the heart interfering with other pulses propagated in the ordinary way through the air to the organ of hearing.

VIBRATIONS OCCASIONED BY WATER FALLING OVER DAMS.

At the Montreal meeting of the American Association for the Promotion of Science, Professor Snell of Amherst, presented a communication on the vibrations occasioned by the water falling over the dam across the Connecticut river at Hadley and Holyoke, Mass.

He first described the dam as a structure 1017 feet in length and thirty feet high, over which, at the time of his observations, about two feet of water was falling in an unbroken sheet. By descending to the base of the dam and looking behind the sheet of water, the currents of air rushing in and out could be perceptibly felt. These currents were set in motion by the water, and were vibratory. The action of the water produced rarefication, which in turn produced the pulsatory motion of the sheet, — the smallness of the space not being sufficiently large to allow a current through the entire length. These vibrations varied ; when the thermometer was at eighty, and the water two feet in depth, the vibrations were 137 per minute. When the temperature was at seventy, the vibrations were 130.

The vibrations were in two segments, alternating with each other generally, and were sufficient at times to throw the sheet of water at its base ten inches outward, — produced, he did not doubt, by the pressure of the air behind. They were communicated to the ground, and were of sufficient force at times to be felt at Springfield, eight miles distant, pulsating the windows and doors at the same rate, 137 per minute !

Professor Hitchcock endorsed the view presented, and said that he had repeatedly seen the vibrations from a hill four miles distant, and it was a most beautiful sight.

Mr. Charles Stodder of Boston, however, in a paper recently read before

the Natural History Society, opposes the theory presented by Professor Snell, and considers that it is entirely disproved by a dam at Lewiston, where the water falls over an inclined plane, leaving no space for air under it, and yet the vibrations are very decided.

According to the views of Mr. Stodder, the phenomenon is caused by that property of falling fluids by which they assume the globular form, which may be seen at the Kauterskill Falls on the Catskill Mountains, where the whole body of the falling water is broken into drops. Applying this principle to the fall over an artificial dam, the water at the very commencement of its descent begins to assume that form, and the further it descends the nearer it approaches to it. In passing over a dam like that at Hadley, the water presents a uniform depth throughout the whole length of the dam, and if we imagine the current of water to be an infinitude of small streams of uniform depth in contact with one another, each having the same tendency, the result must be to produce swellings and contractions throughout the whole extent of the dam. When each of these waves strikes the bottom, it gives a blow proportioned in force to the body of water falling from the height of the dam. Every variation in the depth of the water causes a variation in the size and distance of the waves, each of these causes a concussion in proportionate intensity to the weight of water in it, and in rapidity to their distance apart. These effects of falling water should be expected in general only on artificial falls, such as mill dams." Respecting natural falls, he says: — "As their faces are rarely vertical, but are broken with angular rocks, causing various depths of water on them, and as every variety of depth alters the conditions to form the concussive pulsations, there is no coincidence among them, so that the waves of one part strike the bottom in the intervals of those of another part, and thus the concussion of one neutralizes the other. At Hadley, the dam is one right line from bank to bank, the bed of the river is solid rock, and the top of the dam is level. The waves or pulsations of falling water are uniform, and strike the bottom with sychronous concussion from one end of the dam to the other. It is not surprising that the earth should be felt to vibrate at a great distance."

RAPIDITY OF THOUGHT, OR NERVOUS ACTION.

The method of transforming the valuation of time into space by the rapid revolution of a cylinder, proposed by Mr. Fizeau, has been applied to the measurement of the rapidity of nervous impulse. Such a cylinder rotating 1000 times a second, and divided into 360 degrees, may measure 1–360,000th part of a second; or rotating 1500 times a second, 1–540,000th part of a second; and even this may be subdivided by a microscope, so as to obtain the ten-millionth or perhaps 100-millionth part of a second. By this extreme minuteness of subdivision of time, it is not difficult to measure even the rapidity of a nervous impulse. If an electric shock be given to the arm, it produces a sensation, and a contraction of the muscles. Hence by noting the interval of time between the shock and the contraction, the time occupied by the transmission of the sensation and the action of the brain, however quick, will be determined. By trying the experiment with different

parts of the body, sensible differences have been observed, the shock applied to the thumb being one-thirtieth of a second behind that applied to the face; and this difference pertains to the transmission and not to the action of the brain, and hence enables us to eliminate the latter in the experiments. In this way it has been found by M. Helmholtz, by whom these experiments have been made with the most care,

1. That sensations are transmitted to the brain at a rapidity of about 180 *feet per second*, or at one-fifth the rate of sound; and this is nearly the same in all individuals.

2. The brain requires *one-tenth of a second* to transmit its orders to the nerves which preside over voluntary motion; but this amount varies much in different individuals, and in the same individual at different times, according to the disposition or the condition at the time, and is more regular, the more sustained the attention.

3. The time required to transmit an order to the muscles by the motor nerves, is nearly the same as that required by the nerves of sensation to pass a sensation; moreover it passes nearly one-hundredth of a second before the muscles are put in motion.

4. The whole operation requires one and a quarter to two tenths of a second.

Consequently when we speak of an active, ardent mind, or of one that is slow, cold or apathetic, it is not a mere figure of rhetoric. — *M. Ule, Revue Suisse.*

ON THE ESTABLISHMENT OF UNIFORM TIME BY MEANS OF THE TELEGRAPH.

Mr. J. J. Murphy, at the British Association, communicated a paper containing a proposal for the establishment of a uniform reckoning of time over the world in connection with the telegraph. The paper stated that the period, in all probability, was not remote when the telegraph would effect an almost instantaneous communication between parts of the world which are separated by an extensive arc of longitude, and differ in their solar time by several hours. The system which had been introduced all over Great Britain of keeping Greenwich time everywhere, could not be applied over extensive arcs of longitude. A difference of half an hour between solar time and clock time at any place was no inconvenience, but a difference of six hours would be much too great. It would be necessary for distant places to continue to keep their local solar time; but in order to time the receipt and despatch by telegraphic messages it would be necessary either to reduce the time of one place to that of any other with which it might communicate, or to adopt a uniform reckoning of time for all. We have to propose a simple and self-acting method of meeting the requirements of the case. Let every telegraph station that communicated with distant stations be furnished with a clock, similar in other respects to a common clock, but provided with a double circle of figures on the dial, the inner circle being fixed as in a common clock, but the outer one capable of being moved round. Let some one meridian, say that of

Greenwich, be chosen, to which all others should be referred. Let every such clock throughout the world indicate Greenwich time on the inner or stationary circle of figures, but when the clock is set up at any station, let the outer circle be moved round, and so set that while the hour hand shows Greenwich time on the inner circle, it may show local solar time on the outer one, and let messages be dated in both local and Greenwich time. The perfect convenience of this plan was obvious. It reconciled the necessity of keeping local time with the advantage of uniform time, and got rid of any trouble in reducing the one into the other. The system might be rendered more workable still by abolishing the distinction of east and west longitude, reckoning all east or all west from 0 degree to 360 minutes, and by abolishing the distinction of a. m. and p. m., reckoning time from midnight to midnight, up to twenty-four o'clock.

SELF-INDICATING BALANCE BAROMETER.

M. Secchi, of Rome, has recently invented a new construction of barometer, which possesses the advantages of not being liable to be broken, of giving the readings exact, which Aneroids and others do not, and of recording those readings by self-acting mechanism. M. Secchi says that all improvements hitherto have been limited to the employment of large tubes to avoid the evils of capillary attraction, and to the obtaining of greater exactitude in the readings. All attempts to make the instrument graphic — that is to say, self-acting to record the different variations, and to make the indications more minute — have not yet been successful. The principles on which the new barometer is constructed will be understood by the following statement: — Suppose the cuvette of a barometer to be placed on a table and the glass tube so arranged as to admit of its being lifted by hand. The force that will be required to lift the tube will be equal to the weight of mercury in the tube, or in other words, to the amount of atmospheric pressure exercised on the mercury of the instrument. We shall therefore be able to really weigh the pressure of the atmosphere by attaching the barometer (the tube only) to one end of a balance, and weights to the other; for it is evident that at every change in atmospheric pressure a corresponding increase or decrease in weight will have to be made at the other end of the balance to maintain equilibrium. To ascertain the value of absolute pressure on a unity of surface, it will be necessary to take into consideration the weight of the tube, and also of the weight of that portion thereof which is immersed in the mercury contained in the cuvette, and especially the internal sectional area. The knowledge of the latter, so far from being an obstacle, is a positive advantage in construction; for, by increasing the sectional area, the force that actuates the instrument will also be increased, and will consequently permit of more exact and more minute readings. If the sectional area be ten squares centimetres, and the pressure varies by centimetres in height, the weight to be placed at the other end of the balance will be that of nineteen cubical centimetres of mercury, or one hundred and thirty-five grammes; while, if

the sectional area had been equal to one square centimetre only, the weight would have been but 13·5 grammes.

Starting from these observations, M. Secchi adopted the following construction for his barometer; which has been made and used in the observatory at Rome. The barometrical tube is attached to one end of a steelyard or balanced lever, which carries at the other end a counterbalance weight and a pointer, fifteen millimetres, or five-eighth inch diameter, which is reflected in a mirror. This mirror also reflects a graduated scale, so that the variation of one-tenth of a line of the pointer is indicated by a movement of six lines on the reflected image. The writer enumerates the following advantages peculiar to his invention:—1. As the atmospheric pressure is weighed, and not indicated by the height of the column of mercury, the tube may be constructed of any non-fragile material, such as iron, which does not amalgamate with the mercury, provided the bore be of equal diameter throughout. 2. By increasing the sectional area of the tube, the additional weight will give sufficient motive power to a pencil attached to the other end of the lever to mark the variations of atmospheric pressure. 3. By the intervention of suitable gearing, the scale of observations may be augmented without inconvenience or danger to the exactness of the instrument. 4. The new construction is independent of the form of the miniscus, of the purity of mercury, of its specific gravity, and of the temperature and difference of gravity peculiar to different latitudes, for all these qualities exercise influence upon the volume of mercury, and on the height of the column of mercury in the tube, which has to be measured to obtain the weight of atmospheric pressure, whereas, with the new instrument the weight is given at once. Another advantage of employing iron for barometrical tubes is, that there is no danger to fear from the adhesion of air, or moisture, and the mercury may be boiled without fear of bursting. Iron barometrical tubes will likewise permit of other fluids being employed, and probably advantageously, instead of mercury. M. Secchi states that he invariably found his new barometer indicate variations of atmospheric pressure before ordinary barometers did so, and that by avoiding loss by friction, most exact instruments may be produced.

It has been suggested that this invention may be applied to the construction of audible or danger-signalizing barometers, which, if placed on board a ship, would tell the captain and whole crew of the approach of storms; or which, if placed in mines, would warn miners and inspectors of the presence of fire-damp, as well as indicate its precise locality. For this purpose it would be only necessary to employ a weighing barometer, the pointing of which was composed of some suitable conducting material, but insulated from the rest of the instrument. The pointer should be in communication with one of the poles of an electro-magnetic battery. The dial, over the face of which the pointer would have to travel, should be composed of glass, or other suitable non-conducting material, with metallic points inserted at those gradations, which indicate dangerous variations of atmospheric pressure. These points would have to be placed in communication with the other pole of the battery. The reader will readily see by this arrangement, that when the pressure of the atmosphere shows the presence of danger, either at sea

from storms or squalls, or in mines from the accumulation of carburetted hydrogen gas, the pointer will come in contact with the metallic danger-point in the face of the dial, and so complete the electric circuit which would have the effect, by the intervention of the ordinary or well-known apparatus of sounding an alarum, either by ringing a bell or exploding gunpowder. The arrangements may be varied to suit the particular case, by making the dial of some conducting material and the danger-points of non-conducting material, so that it would be the breaking of the electric circuit that would give the alarm. In the case of ships the barometer might be placed in the captain's cabin with an alarum there, and another on deck near the wheel. While in mines a barometer should be placed in every gallery with an alarum to warn the miners who might be there; and it should also be in communication with an alarum and corresponding dial indicator at the mouth of the pit, so that the overlooker might at all times know the state of the atmosphere in every part of the mine, and be warned of the first approach of danger.

Guynne's Barometer.—This new invention consists of an inverted glass syphon, sealed at one end and open at the other, partly filled with mercury, and suspended, so that the two limbs of the syphon form the arms of a balance. The invention consists chiefly in supporting or balancing the instrument on points, pivots, or knife-edges, or suspending it by a flexible material, as a silken cord, a fine flexible steel spring, &c., which allows the instrument to vibrate or oscillate freely, and a pointer or hand fixed to the instrument, and moving in front of an index or dial, shows by its motion the most minute change in the atmosphere. Any increase in the pressure of the atmosphere forces the mercury towards the sealed end of the tube, giving a preponderance to that side of the syphon, and, consequently, motion to the instrument; while a decrease in the pressure produces an effect in the opposite direction. A great many varieties in the arrangement of the instrument may be made.

CHRONOMETER COMPASS.

By means of this instrument, which is a combination of a universal dial and chronometer, the inventor, Mr. Ralph Reeder, of Cincinnati, claims to be enabled to take any horizontal bearing, in any latitude, at any time of the day, by bringing the shadow of the gnomon to its proper place. The gnomon revolves by means of the chronometer, so as to perform one revolution in twenty-four hours; and when the instrument is levelled and elevated to true latitude, and adjusted at the meridian, the gnomon points steadily to the sun, which it follows in its course. And conversely, if the instrument be levelled and elevated to the latitude of the place, and turned round horizontally till the gnomon points to the sun, or till the shadow falls on the proper point, it will be adjusted to the meridian, and an angle or bearing may be laid off by a horizontal gradual motion. It will also solve practically all the problems which can be solved by any armillary sphere, or by spherical trigonometry, so far as its circles and its motions extend. Thus, the declination and the time given, it will show the altitude and the latitude at any hour and at any place. The instrument is constructed on correct mathe-

matical principles, and will be useful in high latitudes where the needle traverses badly. Its accuracy depends on the correctness of the chronometer, by which the index, or gnomon, is moved, and upon its adjustment to the meridian of the place.

ABBOT'S HOROMETER.

The following is a description of a new nautical and astronomical instrument recently invented by the Rev. Amos Abbot, a missionary connected with the American Board:

A plane metallic hemisphere of ten-inch radius, with a graduated arc and an orthographic projection of lines of latitude divided by dots into minutes of time, and numbered from six o'clock towards the arc for the A. M., and from the arc for the P. M., is the foundation. Moving from the centre of this projection is an index arm, like a quadrant, with a Vernier, reading to half minutes, and upon this arm, sliding in a groove, and at right angles to it is a bar, graduated for a scale of altitudes and comprehending the appropriate corrections. This scale-bar, of course, moves with the index arm, and is always perpendicular to it, and across it a plane glass, with fine lines upon its surface, is made to slide so that it may be set to any given altitude. By this simple combination of parts, the time from an altitude of the sun, moon, planet, or star, is readily worked. Latitude, by various means, is determined; a lunar distance is cleared; azimuth, without a compass, is found; and, in short, all spherical problems are solved by inspection. The plan of the instrument is obvious to a person familiar with spherical trigonometry, correct, and the execution of it so nice, that its accuracy is easily demonstrated by examples.

CAVENDY'S NAUTICAL TRIPOD.

An instrument for obtaining nautical observations in thick weather, invented by Capt. Cavendy, of New York, consists of a metallic tube, supported by a tripod on a universal hinge, so as to keep it in a vertical position, with its point constantly to the zenith. Through this tube the position of the sun is ascertained at meridian, and by the angle obtained between it and the zenith the basis for calculating correct observations is obtained, while the use of the quadrant to give correct observations would require a clear horizon. This instrument is highly commended.

CONTRIBUTIONS TO OUR KNOWLEDGE OF THE CONDITIONS OF THUNDER STORMS.

Mr. John Wise, the eminent American Æronaut, has recently published, in the New York Tribune, the following very curious observations on the physical aspect of thunder storms, which have been made by him from time to time during his numerous balloon ascensions:

A Storm viewed from above the clouds has the appearance of ebullition. The upper surface of the cloud is bulged upward and outward, and has the resemblance of a vast sea of snow boiling and upheaving from internal con-

vulsion. The view is from a point where the atmosphere is clear, around and above. Immediately above the storm the air is not so cold as in a place where there is no cloud nor storm beneath. The falling of the rain can be heard above the cloud, making a noise like a waterfall over a precipice. The thunder heard above the cloud is not loud, and the flashes of lightning appear like streaks of intensely-white fire on a surface of white vapor.

A Side View of a Storm — observed when it is a mile or two off and somewhat lower than the point of observation — presents in form the shape of an hour-glass; the picture of a waterspout also gives a good outline of its shape. In this well-defined form it moves along over the earth. When the storm is so small that you can embrace its whole bulk at a single glance — which you can do when you are several miles off and a little more elevated than the meteor — it looks as though it were trailing its lower base along on the surface of the earth, and it has an individuality which cannot be recognized when viewed from the ground. Although the storm is being moved along by the same current of wind that is drifting along the observer, it will be deflected from that course by its encountering a mountain ridge or a deep valley, just in proportion to the amount of lateral force or obstruction it sustains in such cases; and then the observer in a balloon may continue onward, while the storm may be moving off at right angles with his route. These lateral views of storms are very grand and imposing as they rush along by an elevated observer.

A Closer View from the Side of a Storm, and partly in it, reveals a very interesting physical aspect. The one now described occurred on the 3d of June, 1852, during a balloon excursion from Portsmouth, Ohio. The storm was kedging up the Ohio River, about fifty miles above Portsmouth, and where the river courses nearly north and south, while I was sailing from west to east. Moving at nearly right angles with the storm, soon brought us together, and the country below being dense forest, the meteor's company was preferred to a reception in the woods. It was easy to keep out of the vortex of the storm from an abundant supply of ballast aboard of the airship; hence a point in its wake was the station of observing its action, and having learned that the shape of storms was like two cones with their ends joined, with a wind driving in below and rushing out again at its top, you might sail with impunity in its wake, provided you kept midway between the upper and lower cloud. When getting too low in its wake there was a tendency to rock the balloon into the vortex, but this was countervailed by going up near the out-spreading cloud. In this position the air is cold, and you are in the shadow of the upper cloud, unless you sink low enough where the sun may reach you under the overlapping cloud. Although the sun was shining on me, the rain and small hail were rattling on the balloon. A rainbow was standing in and against the body of the meteor, or rather a prismatically colored arch the shape of a horse-shoe was reflected against it, and as the point of observation changed laterally and perpendicularly, the perspective of this golden grotto changed its hues and forms. Above and behind this arch there was going on the most terrific thunder, but no zig-zag lightning was perceptible, only bright flashes like explosions of "Roman

candles" in fireworks. Occasionally there would be a zig-zag explosion in the cloud immediately below, and the thunder therefrom sounded like a "feu de joie" of a rifle corps. Once an orange-colored wave of light seemed to fall from the upper to the lower cloud, and right over the balloon, but no sensible effect was produced by its contact. This was "still lightning." There appeared all the time while in the storm electrical action going on in the balloon, such as expansion, tremulous tension, attraction by lifting papers out of the car ten feet below the balloon, and hugging them to its body for a moment and then letting them drop off again; but as I had no instruments I can only relate the manifestations of electricity in this case. While, as stated above, a distant view of storms is imposing and grand, a closer view of a great storm such as this Ohio meteor, is truly sublime; although the rushing noise below and in its midst, is almost appalling.

The Quantity and Quality of Thunder seem to be in proportion to the magnitude of the storm. A storm may be so limited in size as that there will be no electrical explosions. In this case the developed electricity can be dissipated and taken up by the immediately surrounding cloud formation. April and May showers are an exemplification of this fact. When the storm is of great magnitude the central portion of its top becomes surcharged with electricity, because the surrounding cloud-formed vapor cannot conduct away silently as fast as it is developed, and hence explosions must ensue, such as noticed in the Ohio meteor, with terrific and rapid discharges of thunder; and moreover, the drops of rain that are formed from this surcharged vapor of the upper cloud also become redundantly electrified, and although they fall quietly down through the intervening clear air which is a non-conductor, as soon as they reach the lower cloud, which is negatively electrified, they give up their surplus — silently if the capacity of this cloud is sufficient to take it up, but explosively if the cloud is insufficient; and it may fly off laterally until dissipated, or it may glance downward to the earth, rending whatever it encounters before its diffusion in the earth. The physical facts here stated are as I saw them; the rationale of explosion is confirmed from the known play of electricity as divulged by the common electrical machine experiments.

A Storm Viewed from within its Caldron — that is, from within its vortex, where the cloud-vapor is driving upward to where it spreads out — is rather a terrible thing, and the very fact that you are caught up in the midst of one of nature's laboratory furnaces makes you feel resigned, and determined to look to the end thereof. It may be only terrible because we are not used to it; nevertheless, I would not like to enter one again for observation until science dictates, without a doubt, that we are not liable to annihilation or serious harm. The one now to be described is the result of a trip in the midst of a local storm of so limited dimensions as to have no electrical explosions during my passage of nineteen minutes within its bosom. This storm originated nearly over the town of Carlisle, Pennsylvania, on the 17th of June, 1843. I entered it just as it was forming. The nucleus cloud above was just spreading out as I entered the vortex unsuspectingly. I was

hurled into it so quick that I had no opportunity of viewing its surroundings outside, and must therefore confine this relation to its internal action. On entering it, the motion of the air swung the balloon to and fro, as also around in a circle, and a dismal howling noise accompanied this unpleasant and sickening motion; and in a few minutes thereafter was heard the falling of heavy rain below, resembling in sound a cataract. The color of the cloud, internally, was of a milky hue, somewhat like a dense body of steam in the open air, and the cold was so sharp that my beard became bushy with hoar-frost. As there were no electrical explosions in this storm during my incarceration, it might have been borne comfortably enough but for the sea-sickness occasioned by the agitated air-storm. Still, I could hear and see, and even smell, everything close by and around. Little pellets of snow (with an icy nucleus when broken) were pattering profusely around me in promiscuous and confused disorder, and slight blasts of wind seemed occasionally to penetrate this cloud laterally, notwithstanding there was an upmoving column of wind all the while. This upmoving stream would carry the balloon up to a point in the upper cloud, where its force was expended by the outspreading of its vapor, whence the balloon would be thrown outward, fall down some distance, then be drawn into the vortex, again to be carried upward to perform the same revolution until I had gone through the cold furnace seven or eight times; and all this time the smell of sulphur, or what is now termed ozone, was perceptible, and I was sweating profusely from some cause unknown to me, unless it was from undue excitement. The last time of descent in this cloud brought the balloon through its base, where, instead of the pellets of snow, there was encountered a drenching rain, with which I came down into a clear field, and the storm passed on. This storm may have been accompanied with electrical discharges after it left me, as it had the appearance of increase as it departed. I may here mention that the people in the neighborhood informed me next day that it deposited two parallel trains of hail some distance apart. I have frequently since and before this occurrence witnessed storms while up in the air, but a great distance off, sometimes four and five of them at the same time in different parts of the heavens, and always in the months of May and June, and never accompanied with electrical explosions when they were small in dimensions.

Thunder Storms Viewed from the Earth, have not the characteristic shapes lineated to the eye of the observer, as when viewed sidewise from above. Neither does one discover the two plates of clouds joined in conic sections. The upper cloud can be seen rolling outward, and black clouds below centering inward, but the whole seems to be nearly blended in one solid mass. By close observation and practice it will soon be deduced that there are two plates of clouds, even as viewed from the earth. In watching clouds carefully from the earth, it will be observed that vivid zig-zag flashes and heavy peals are followed by copious showers. The rain drops, being positively charged from the upper cloud, drop through a clear atmosphere, which is a non-conductor, into the lower cloud, which is negatively electrified; and if the shower is too copious for the lower cloud's capacity to absorb it silently,

explosions must follow, in the same way as the Leyden jar explodes spontaneously when surcharged to overflowing. Were it not for the lower cloud and its negative condition, the surcharged drops of rain would scintillate their electrical fire as they touched the earth.

Thunder-storms rage more violently as they pass over forests and moist places, and were it not for the deposition of rain as they pass along their track, would exhibit a parched trail. A long drought is adverse to the generation of a thunder-storm, and on the other hand a moist earth is promotive of one.

Thunder-storms are deflected from their courses, as well as retarded in their movement, by friction on the earth. Ascending from the earth with a balloon in the rear of a storm, and mounting up a thousaud feet above it, the balloon will soon override the storm, and may descend in advance of it. I have experienced this several times.

ON THE DIRECTION OF THE WIND.

Professor Hennessy, at the last meeting of the Britith Association, stated, as the result of his observations with an improved annemometer, that the wind rarely blows in a perfectly horizontal direction. The deviations from that direction, although usually very small, are sometimes very remarkable, and follow each other in such a way, especially during strong breezes, as to indicate a species of undulatory motion in the wind.

ON THE SPIRALITY OF MOTION IN WHIRLWINDS AND TORNADOES.

The following important paper was read before the American Association for 1856, by the late W. C. Redfield, and subsequently published in Silliman's journal.

1. An aggregated spiral movement around a smaller axial space, constitutes the essential portion of whirlwinds and tornadoes.

2. The course of the spiral rotation, whether to the right or left, is, one and the same in this respect throughout the entire whirling body, so long as its entegrity is preserved. But the oblique inclination which the spiral movement also has to the plane of the horizon, is in opposite directions as regards the interior and exterior portions of the revolving mass. Thus, in the outward portion of the whirlwind the tendency of this movement is obliquely downward, where the axis is vertical; but in the interior portion, the inclination or tendency of the spiral movement is upward. This fact explains the ascensive effects which are observed in tornadoes and in more diminutive whirlwinds.

3. Owing to the increased pressure of the circumjacent air in approaching the earth's surface, the normal course of the gradually descending movement, in a symmetric whirlwind, is that of an involuted or closing spiral; while the course of the interior ascending movement of rotation, is that of an evolved or opening spiral. Hence, the horizontal areas of the higher portions of the whirl exceed greatly those of its lower portions.

4. The area of the ascending spiral movement in the vortex, as it leaves the earth's surface, is by far the smallest portion of the whirling body; for the reason that the rotation here is proportionally more active and intense, being impelled by the aggregated pressure and momentum of the more outward portion of the whirlwind as it converges from its larger area, on all sides by increasingly rapid motion, into the smaller area of ascending rotation.* That this interior portion of the whirl resembles an inverted hollow cone, or column, with quiescent and more rarefied air at its absolute centre, may be inferred from the observations which have been made in the axial portions of the great cyclones. Into this axial area of the tornado the bodies forced upward by the vortex cannot fall, but will be discharged outward, from the ascending whirl. The columnar profile of this axial area sometimes becomes visible, as in the water spouts so called.

5. Accessions caused by circumjacent contact and pressure are constantly accruing to the whirling body, so long as its rotative energy is maintained. A correlative diffusion from its ascending portion must necessarily take place, towards its upper horizon; and this is often manifested by the great extent or accumulation of cloud which results in this manner from the action of the tornado. In other words, there is a constant discharge from the whirling body in the direction of least resistance.

6. The spirality of the rotation and its inclination to the horizon, in the great portion of the whirl which is exterior to its ascending area, is not ordinarily subject to direct observation. Nor is the outline or body of the more outward portion of the whirlwind at all visible, otherwise than in its effects.

7. In *aqueous* vortices the axial spiralities of the exterior and interior portions are in reverse direction to those in the atmosphere, the descending spiral being nearest to the axis of the vortex. Hence, lighter bodies and even bubbles of air are often forced downward in the water, in the manner in which heavier bodies are forced upwards in the atmosphere.

The foregoing is simply a statement of results which I have derived from a long course of observation and inquiry. It does not include the partial and imperfect exhibitions of whirlwind action, which often occur; nor the various movements and phenomena which are collaterally associated with tornadoes and whirlwinds, some of which are of much significance.

* The law of increment in the velocity of the whirlwind, as it gradually converges into smaller areas by its spiral involution, is that which pertains to other bodies when revolving around interior foci towards which they are being gradually drawn or pressed nearer and nearer, in their involute course; the line of focal or centripetal pressure, thus sweeping *equal areas in equal times*, at whatever diminution of distance from the centre; except as the velocity may be affected in degree by the resistance of other bodies. Such resistance is of little effect in a tornado, because its revolving mass is mainly above all ordinary obstacles, such as orchards and forests, into which the spirally *descending* and accelerated blast, near the contracted extremity of the inverted and truncated cone of the whirl penetrates with constant freshness and intensity of force; already acquired in the higher and unobstructed region.

ON THE WARPED SURFACES OF GROUND OCCURRING IN ROAD EXCAVATIONS AND EMBANKMENTS.

The following is an abstract of a paper read before the American Association, at Montreal, by Professor W. M. Gillespie, of Schenectady, N. Y.

To determine the amount of earth necessary to be moved in making the "cuts" and "fills" of roads, engineers take "cross-sections," or "profiles," of the ground at right angles to the line of road, at convenient intervals, and then calculate by various methods, usually near approximations, the volume included between each pair of these cross-sections. The distances apart at which these cross-sections are taken, are determined by the engineer according to the nature of the ground; his aim being that there shall not merely be no abrupt change of height between each pair of these cross-sections, but that the surface from one to the other shall *vary uniformly;* gradually passing, for example, from a small to a great degree of slope, or from a slope to the right into a slope to the left, without any sudden variation at any one place.

The surface fulfilling this condition, since it is everywhere straight in some direction, is evidently a *ruled surface;* and since the extreme profiles are seldom parallel, it will be a *warped* or *twisted* surface.

Our engineers have been accustomed to consider these surfaces as not admitting of precise calculation, but only of a degree of approximation varying with the nearness of the cross-sections. The object of this paper is to examine the correctness of this assumption. It will therefore have two parts: firstly, a discussion of the precise nature of the surface; and secondly, an investigation of a formula applying to it.

I. *What sort of a warped surface is the one in question; that is, what is its mode of generation?*

To determine this, we must examine what the engineer means when he says that the ground "varies uniformly" from the place at which he stands to the place at which he decides it will be proper to take the next cross-section; whether he means that the ground is straight lengthwise, or straight crosswise—straight in the direction the road runs, or straight at right angles to that direction.

Probably few engineers ask themselves this question in so many words; but it would seem that the latter, or *straightness crosswise,* is the more likely to be what is meant, for the reason that any deviation from straightness in that direction, at right angles to the line along which we look, is much more easily seen than in the other direction. We can therefore much more readily determine whether the surface of the road is straight or curved from side to side than from end to end. In geometrical language the former surface (which we will call No. 1) is generated by a straight line resting on the two straight lines which join the extremities of the two profiles, and moving parallel to their planes, or perpendicular to the axis of the road.

This surface is a "Hyperbolic Paraboloid."

The latter surface (No. 2) is generated by a straight line resting on the two profiles, and moving parallel to the vertical plane which passes through the axis of the road. It also is a hyperbolic paraboloid, though a different one from the former.

The French engineers adopt the latter hypothesis. We have seen, however, that the former is the more probable one.

But fortunately the difference is really very slight; for a very small change in the latter hypothesis will make its result identical with that of the former. Conceive the straight line which rests on the two profiles to move on them in such a way as always to divide them *proportionally*. The surface thus generated (No. 3) is identical with No. 1.

This last conception is also more probably correct than No. 2 — even if we suppose the engineer to consider longitudinal straightness — since he is more likely to extend his imagination from all parts of one profile to all parts of the other, than in lines perpendicular to the profile on which he stands.

II. We shall therefore now proceed to investigate the content of a solid, bounded on one face by a warped surface, generated on the first hypothesis — the other faces being planes.

We will take the case of an Excavation; that of an embankment being the same inverted.

We will begin by considering the sides of the excavation to be vertical; and will afterwards discuss the more usual form.

[The mathematical discussion is here omitted. The result of the integration shows the required volume of the solid to be expressed by this simple and symmetrical formula:

$$\tfrac{1}{6}\left[(b+\tfrac{1}{2}b')\,(g+h)+(b'+\tfrac{1}{2}b)\,(g'+h')\right].$$

In it l is the length of the solid; b and b' are the breadths of its two ends; g and h the side depths at one end; and g' and h' those at the other end.

It is next shown that the expression for the volume obtained by treating the solid as a prismoid can be transformed into the above formula.]

We thus arrive at the practical conclusion that *the familiar "Prismoidal formula" can be applied with perfect accuracy to such solids, having one of their faces a warped surface, generated as in our first, or third, hypothesis.*

The general adoption of these views would enable beginners to economize much time and labor, since they would no longer feel themselves under the necessity of taking their cross sections so near together that the ground between them should be approximately plane, but could take them as far apart as the ground "varied uniformly," no matter how much or how far that might be.

MOLECULAR AGGREGATION OF CRYSTALLINE SOLIDS.

Robert Mallett, the well-known English physicist, in a recent publication, affirms that in the "molecular aggregation of crystalline solids, the crystals always arrange and group themselves with their principal axes in lines per-

pendicular to the cooling or heating surfaces of the solid; that is, in the lines of direction of the heat wave." He assumes, that as a gun, in cooling, radiates heat from the centre outward, in all directions, the particles arrange themselves in radial lines, ready to be separated on the application of a comparatively slight force, thus possessing least strength in the direction where it is most wanted. He illustrates by the following experiment, which might be readily tried: "If a cylinder of lead, some four or five inches long, and of about the same diameter, be cast around a cylindrical bar of iron about an inch and a half in diameter, and considerably longer, the lead becomes rapidly consolidated by the contact of cold material interiorly as well as exteriorly, will have a tolerably homogeneous structure, and may be cut into, beaten out, etc., without exhibiting any trace of crystallization. But if one of the ends of the central bar be heated red-hot, and time be allowed for the heat to be conducted along into the interior of the lead, and thence conducted outward in all directions till the heat is nearly up to the melting point of lead — say to about 550″ Fahr. — and the lead be now sharply struck with a hammer, the whole mass will be found to have a crystalline structure, all the principal axes of the long thin crystals radiating regularly from the centre; and by a few blows from the hammer the mass will separate and fall to pieces, so complete are the planes of separation."

As a consequence of this law, it is inferred that every abrupt change in the form of the exterior of any casting, is attended by an equally sudden change in the arrangement of the crystals, accompanied with one or more planes of weakness in the mass. The small cast iron cylinder of the hydraulic press used in raising the tubes of the Britannia Bridge, failed under the immense pressure, until another form was substituted with a bottom more rounded; and the theory laid down, and to a certain extent established by this writer, would seem to indicate that when angular forms are absolutely required in castings exposed to great strains, it might be expedient to cast the parts in rounded forms, and then turn or plane them to the forms required.

ILLUSTRATIONS OF DRAINAGE.

Mr. Trachzel, in a recent lecture on drainage, before the London Society of Arts, illustrated his remarks by means of a tin vessel, fitted with two spouts. The bottom of the vessel represented what he termed the "water table," or the formation which prevented the water sinking lower, and the two spouts represented drains at different depths. Having filled the vessel with pebbles, he poured in some water, which, descending to the bottom, ran out of the lower spout or drain. Stopping the lower spout, the water ran out of the upper drain. In the same manner, he said, water descended through the soil as low as it could, and hence the importance of deep draining. Water did not by instinct run into the drains, but saturated the soil, and to be carried away drains must be made at a proper depth. A three feet drain would drain the land to the depth of two feet six inches only, while the root of wheat required a considerably greater depth, running in favorable situations to the depth of four feet, and as deep, in fact, as the

plant itself was high. From what he had described, it would be seen that the land must contain an immense amount of water before the shallow drain would operate. Where there were two sets of drains, one shallow and the other deep, the shallow drains would be useless except to introduce air into the soil. It should, however, be observed that if the soil were sufficiently deep, drains might be placed at too great a depth. Since drainage had become so general, millers in many parts of the country complained of the want of water. This was owing to the level of the water being brought to a point at which it was useless to fill the ponds. Draining one field, also, would have the effect of draining the neighboring land, and if there were a large area of the same kind of land, gravelly soil, for instance, one large drain would suffice to drain the land for twenty miles round. The distance at which drains should be made, must depend upon the nature of the soil. If the soil were loose and gravelly, they might make the drains as far apart as they chose; but if the land were stiff and close, then they should make the drains as near together as they could afford.

ON THE VESICULAR THEORY OF MIST.

A paper has recently been presented to the French Academy by the Abbe Railland, which denies the truth of the vesicular vapor theory concerning clouds, and contends that the phenomenon in question depends on minute divisions. As gold, when beaten into leaf, falls slowly, so the more the surfaces of water are increased, the more slowly will the water fall. The resistance of air to a drop divided into a thousand parts, is a thousand times greater than to a single drop. Hence clouds are borne up by the friction of the atmosphere. That clouds should consist of vesicular vapor is, in the abbe's opinion, simply impossible; for if it were vesicular, it would be condensed; and if air were contained within the vesicles, the viscosity of the husk or shell would have to be something very different from that of water.

M. de Tessan, an eminent French meteorologist, has also published conclusions to the same effect.

ESTIMATION OF SPECIFIC GRAVITY.

M.M. Vogel and Reischauer recommend the use of a flask with a flattened bulb for the purpose of estimating the specific gravity of liquids that are much affected by change of temperature. With such a flask the equalization of temperature is effected with much greater facility than in a flask of the ordinary form. This flask is filled and emptied by means of a pipette of equal capacity, with a long thin beak. The neck of the flask is graduated, each division representing a known fraction of the volume of the flask. By this means it is not requisite to remove any liquid from the flask by filter paper. In order to derive full advantage from the shape of the flask, it is necessary, on account of the uncertainty of reading off, that the neck of the flask should be very narrow, otherwise the advantage in observing the temperature is lost, especially in the case of liquids, whose expansion is not widely different from that of water.

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CURIOUS PHENOMENA OF ICE.

At the Montreal meeting of the American Association, Professor Henry presented a paper entitled, " Some Phenomena of Ice."

In the commencement he stated, that if anything strange or curious occurs in any part of the country, the Smithsonian Institution was quite sure to hear of it, and in this way more questions were propounded to its officers than wise men could always answer. A year ago last winter, on a very cold day, a countryman called upon him and stated that he had come twenty miles to show him something which he thought very extraordinary. The article was a common tin milk-pan filled with frozen water. On the top of the ice, rising in its centre, was a strange formation, created without apparent cause, consisting of a crystal of ice protruding in a direction oblique to the general surface, in shape something like an isosceles triangle, with its sides slightly curved and corrugated, and its centre hollow. The countryman stated that the pan of water had stood in a cold entry way over night, where it had not been disturbed or agitated in freezing, and he desired to know what had caused it to assume this remarkable form, shooting out a pyramid from its centre.

Professor Henry was unable at the time to answer satisfactorily, but had a drawing made of the object, and laid it aside for future investigation. Last winter he received another communication, making inquiries in relation to extraordinary workings of ice and the ground which took place at that time. Reflecting upon the latter phenomenon, an explanation of the milk-pan curiosity also occurred to him. It was well known that, in the process of the solidification of melted metals, and the freezing of water, the crystals are produced in the direction of the surface from which the heat escapes. In the freezing of the water in a vessel of the milk-pan shape, the crystals ran across in nearly horizontal lines, crossing each other at an angle of sixty degrees. The water freezing first from the sides and bottom of the vessel, left in the centre and top a triangular space, which the yet unfrozen but still expanding water found too small for it. This unfrozen water was forced up by hydrostatic pressure, above the frozen surface surrounding it, and held by capillary attraction in this position, until its edges became a ring, or rather a corrugated base section of the future triangular pyramid. When this became frozen, the process of solidifying, still progressing below, continued to force up the water, until another and another section was raised, and the column entirely completed.

Water in the act of congealing expands; but after it has once been frozen into ice, it follows the law of all solids, contracting with cold and expanding with heat. Indeed it has been proven to shrink even more than any other solid. This explains the cracking of ice on the lakes, with loud explosions, in very cold weather — the ice shrinking and parting. The cracks always occur in the place of least resistance, as, for instance, in the narrowest part of the body of water frozen over. The professor stated further, that the crystals formed on the surface of large bodies of water in the process of freezing were nearly perpendicular, the coating surface being that exposed to

the cold winds. This was easily seen as the ice decayed from exposure to the sun or south wind, when it breaks to pieces all small columns, the crystals separating each from the other. When ice shrinks and cracks, the edges fall down upon the water, forcing the latter up between them. This water, in freezing, expands, and then finds the fissure too small to accommodate its increased bulk, — the consequence of which is, that a ridge is thrown up. The same effect is increased by the subsequent expansion consequent on the occurrence of warm weather, crushing the newly-formed ice to heaps or mounds.

ON THE PLASTICITY OF ICE.

Mr. James Thomson, in a paper on the above subject before the British Association, Dublin, commenced by stating that to Professor James Forbes is to be attributed the discovery that the motion of glaciers down their valleys depends on a plastic or viscous quality of the ice. He (Mr. Thomson) had formed a theory to explain the nature of this plasticity, and the manner in which it originates. He had been led to his speculations on this subject from a previous theoretical deduction at which he had arrived, namely, that the freezing point of water, or the melting point of ice, must vary with the pressure to which the water or the ice is subjected, the temperature of the freezing point being lowered as the pressure is increased. His theory on that matter led to the conclusion that the lowering of the freezing point for one additional atmosphere of pressure must be 0·0075° centigrade, and that the lowering of the freezing point corresponding to other pressures must be proportional to the additional pressure above one atmosphere. The phenomena which he thus predicted, in anticipation of direct observations, were afterwards fully established by experiments made by his brother, Prof. William Thomson, of which an account was published in the "Proceedings of the Royal Socieiy of Edinburgh for Feb. 1850." Having thus laid down as a basis the principle of the lowering of the freezing point of water by pressure, Mr. Thomson proceeded to offer his explanation, derived from it, of the plasticity of ice at the freezing point, as follows: If to a mass of ice at 0° centigrade, which may be supposed, for the present, to be slightly porous, and to contain small quantities of liquid water diffused through its substance, forces tending to change its form be applied, whatever portions of it may thereby be subjected to compression will instantly have their melting point lowered so as to be below their existing temperature of 0° centigrade. Melting of those portions will therefore set in throughout their substance, and this will be accompanied by a fall of temperature in them, on account of the cold evolved in the liquefaction. The liquefied portions being subjected to squeezing of the compressed mass in which they originate, will spread themselves out through the pores of the general mass, by dispersion from the regions of greatest to those of least fluid pressure. Thus, the fluid pressure is relieved in those portions in which the compression and liquefaction of the ice had set in, accompanied by the lowering of temperature. On the removal of this cause of liquidity, the fluid pressure, namely, the cold, which had been evolved in the compressed parts of the ice and water,

freezes the water again in new positions, and thus a change of form, or plastic yielding of the mass of ice to the applied pressures, has occurred. The newly-formed ice is at first free from the stress of the applied forces, but the yielding of one part always leaves some other part exposed to the pressure, and that part, in its turn, melts and falls in temperature; and, on the whole, a continual succession goes on, of pressures being applied to particular parts — liquefaction occurring in those parts accompanied by evolution of cold,— dispersion of the water so produced in such directions as will relieve its pressure, and re-congelation, by the cold previously evolved, of the water on its being relieved from this pressure. The cycle of operations then begins again, for the parts re-congealed, after having been melted, must, in their turn, through the yielding of other parts, receive pressures from the applied forces, thereby to be again liquefied, and to proceed through successive operations as before. The succession of these processes must continue as long as the external forces tending to change of form remain applied to the mass of porous ice permeated by minute quantities of liquid water. The ice is thus shown to be incapable of opposing a permanent resistance to the pressures, and to be subjected to gradual changes of form while they act on it; or, in other words, it has been shown to be possessed of the quality of plasticity. In the foregoing, I have supposed the ice under consideration to be porous, and to contain small quantities of liquid water diffused through its substance. Porosity and permeation by liquid water are generally understood, from the results of observations, and from numerous other reasons, to be normal conditions of glacier ice. It is not, however, necessary for the purposes of my explanation of the plasticity of ice at the freezing point, that the ice should be, at the outset, in this condition; for, even if we commence with the consideration of a mass of ice perfectly free from porosity, and free from particles of liquid water diffused through its substance, and if we suppose it to be kept in an atmosphere at or above 0° centigrade, then, as soon as pressure is applied to it, pores occupied by liquid water must instantly be formed in the compressed parts, in accordance with the fundamental principle of the explanation which I have proposed — the lowering, namely, of the freezing or melting point by pressure, and the cognate fact, that ice cannot exist at 0° centigrade under a pressure exceeding that of the atmosphere. I would further wish to make it distinctly understood, that no part of the ice, even if supposed at the outset to be solid, or free from porosity, can resist being permeated by the water squeezed against it from such parts as may be directly subjected to the pressure; because, the very fact of that water being forced against any portions of the ice supposed to be solid, will instantly subject them to pressure, and so will cause melting to set in throughout their substance, thereby reducing them immediately to the porous condition. Thus it is a matter of indifference, as to whether we commence with the supposition of a mass of porous or of solid ice. Mr. Thomson then referred to an experiment made by Prof. Christie, late Secretary to the Royal Society, showing the plasticity of ice in small hand specimens, and also to more recent experiments by Prof. Tyndall to the same effect, and very interesting on account of the striking way in which they exhibit the

phenomena. He also stated that another very important quality of ice was brought forward by Faraday in 1850. It was that two pieces of moist ice will consolidate into one on being laid in contact with one another, even in hot weather. The theory he had just propounded, he said, afforded a clear explanation of this fact as follows: The two pieces of ice, on being pressed together at their point of contact, will at that place, in virtue of the pressure, be in part liquefied and reduced in temperature, and the cold evolved in their liquefaction will cause some of the liquid film intervening between the two masses to freeze. It is thus evident, he added, that by continued pressure fragmentary masses of ice may be moulded into a continuous mass; and a sufficient reason is afforded for the reunion, found to occur in glaciers, of the fragments resulting from an ice cascade, and for the mending of the crevasses or deep fissures which result occasionally from their motion along their uneven beds.

CHEMICAL SCIENCE.

ON SOME EXPERIMENTS ON THE TRANSMUTATION OF METALS.

The following very remarkable and suggestive paper, by Dr. J. W. Draper, of New York, is published in the Philosophical Magazine, for November, 1857: —

No one who has used a tithonometer* can have failed to have noticed the disturbing effects of minute quantities of extraneous gases, mingled with chlorine, on photo-chemical induction. My attention has been directed to that subject in its more general aspect; and I will ingenuously confess that I have made several attempts at the transmutation of metals, on the principle of compelling them, by the aid of solar light, to be disengaged from states of combination in the midst of resisting or disturbing media.

The following is a description of one of these alchemical attempts. In the focus of a burning lens, twelve inches in diameter, was placed a glass flask, two inches in diameter, containing nitric acid, diluted with its own volume of water. Into the nitric acid were poured alternately small quantities of a solution of nitrate of silver and of hydrochloric acid, the object being to cause the chloride of silver to form in a minutely divided state, so as to produce a milky liquid, into the interior of which the brilliant convergent cone of light might pass, and the currents generated in the flask by the heat, might drift all the chloride successively through the light. The chloride, if otherwise exposed to the sun, merely blackens upon the surface, the interior parts undergoing no change; this difficulty I hoped, therefore, to avoid. The burning glass promptly brings on a decomposition of the salt, evolving on the one hand chlorine, and disengaging a metal on the other. In one experiment the exposure lasted from 11 A. M. to 1 P. M.; it was, therefore, equal to a continuous mid-day sun of seventy-two hours. The metal was disengaged very well. But what is it? It cannot be silver, since nitric acid has no action upon it. It burnishes in an agate mortar, but its reflection is not like the reflection of silver; it is yellower. The light must therefore have so transmuted the original silver as to enable it to exist in the presence of nitric acid. In 1837 I published some experiments on the nature of this decomposition, in the Journal of the Franklin Institute.

Though this experiment, and several modifications of it, which I might relate, fail to establish any permanent change in the metal under trial, in the

* *An arrangement for measuring the chemical action of light.*

sense of an actual transmutation, it does not follow that we should despair of a final success. It is not likely that nature has made fifty elementary substances of a metallic form, many of them so closely resembling one another as to be with difficulty distinguished; moreover, chlorine and other elementary substances can be changed by the influence of sun-light in some respects permanently; and if silver has not thus far been transmuted into a more noble metal, as platinum and gold, it has at all events been transmuted into something which is not silver. Those who will reflect a little on the matter cannot fail to observe that the sun-rays possess many of the powers once fabulously imputed to the powder of projection and the philosopher's stone.

DIFFERENT CONDITIONS OF SULPHUR.

Among the chemical researches in France during the last few months, we would refer to those of Berthelot on sulphur, the allotropic states of which element have appeared to be numerous and varied. Berthelot reduces all to two principal states, viz., that of *octahedral sulphur*, soluble in sulphuret of carbon, and that of *amorphous sulphur*, insoluble in this sulphuret. The former he calls *electro-negative* sulphur, for it acts always as a supporter of combustion, and separates from compounds in which it plays an electro-negative part (as SH, S^2C). The insoluble sulphur, on the contrary, is combustible or *electro-positive*, and separates from compounds in which it plays an electro-positive part (SO^2, SO^3, S^2O^2, S^3O^4). Under a similar relation, Berthelot brings with reason the allotropic states of selenium and phosphorus, which have, as is known, each a state soluble and insoluble in sulphuret of carbon. The two conditions of oxygen, ozone and ordinary oxygen, are to be considered as dependent on different electrical states, the ozone electro-negative, and ordinary oxygen electro-positive.

Now that the true principle has been indicated, it will be easy to find analogous facts, for it is one that will prove to be fertile in its applications.—*Silliman's Journal.*

SULPHURIUM.

Mr. Joseph Jones, of England, announces that he has discovered the perfect metal sulphurium, which is of the same class as arsenium, silver, aluminum, &c. Oxide of sulphurium is the refuse of the manufacture of sulphuric acid, or brimstone, and has no commercial value, persons being paid for carting it away. In its refuse condition it has almost the specific gravity of iron, and the atoms are very fine, malleable, ductile, &c.

CRYSTALLINE FORM OF SELENIUM, IODINE AND PHOSPHORUS.

Mitscherlich finds that the form of selenium crystallized from bisulphide of carbon is an oblique rhombic prism. At 116 deg. F., bisulphide of carbon dissolves 0·1 per cent. of selenium, and at 52 deg. F., it dissolves 0·016. The selenium separates, on cooling the solution, as thin transparent red laminæ

with considerable lustre, and as granules that are so dark-colored as to appear almost black. When heated to 212 deg. F., with water, the crystals are not altered in their characters, but when gradually heated to 302 deg. F., they become almost black, and are then quite insoluble in bisulphide of carbon. When the altered crystals are melted, and the mass cooled rapidly, it again dissolves completely in bisulphide of carbon. The density of the crystals before being heated was 4·46 or 4·509 at 59 deg. F., after being heated it was 4·7. The density of selenium crystallized from a solution of selenide of sodium was from 4·760 to 4·788 at 59 deg. F.

It appears that the selenium crystallized from selenide of sodium and the granular crystalline selenium are identical, and essentially different from that crystallized from bisulphate of carbon. In this respect selenium is analogous to sulphur, which also exists in two isomeric states, but selenium has a much greater stability in its isomeric states.

The crystals of iodine obtained in various ways have always the same form, and do not present any of the peculiarities observed in sulphur, selenium, and phosphorus. The crystal form is a rhombic octohedron.

The crystal form of phosphorus is a regular dodecahedron.

Very fine crystals of phosphorus may be obtained by exposing phosphorus to sunlight in a tube either exhausted, or filled with a gas which cannot oxidize it. Professor Mitscherlich states that he has never observed the emission of light from phosphorus during volatilization when oxidizing substances were excluded, so that the emission of light would seem to be essentially connected with oxidation. The crystals of sublimed phosphorus soon acquire a red color in sunlight, without alteration of form, but generally it is only the outside that is altered, and the change does not consist in the production of the isomeric phosphorus described by Schrötter.

ON THE FORM OF CARBON, KNOWN AS "GAS CARBON."

At a recent meeting of the American Academy, Dr. A. A. Hayes presented the following paper, on the form of carbon deposed in retorts used for decomposing coal.

"This form of carbon has been supposed to result from the decomposition of olefiant gas by heat; olefiant gas being one of the products of coal decomposition, under certain conditions, olefiant gas is represented by C^4H^4, the equivalent being four volumes, and when it is exposed to a temperature above redness it deposits carbon in considerable quantity. If exposure and heat be continued, the final result is carbon, as a precipitate, and hydrogen as a gas, free from carbon.

"To render probable the supposition of olefiant gas being the source of the gas carbon, it has been generally stated that this bicarburet loses two of its four proportions of carbon by heat, and becomes converted into marsh gas, or light carburet of hydrogen, the formula of which is C^2H^4; and thus the definiteness of an exact result is presented.

"In the manufacture of gas for lighting, an increased temperature in the retort diminishes the illuminating power of the gas, and hence it has been

assumed that the illuminating effect of the gas is diminished by a loss of the carbon contained in the olefiant gas, to which a large part of the light-giving quality has been attributed. It becomes an interesting point in general chemical science, to learn how far the facts gained by observation and experiment will sustain these assumptions which have been held in relation to the source of gas-carbon as above alluded to, and to inquire into its connections more particularly. Gas carbon, in its difficult combustibility under a current of heated air, its relation to nitrates of the alkalies and sulphuric acid, must be classed with the carbon found in crude iron, and called graphitic carbon, or carbon in an allotropic state. It differs as much from lampblack and charcoal as these do from diamond, and in the artificial production of it, in all the cases hitherto observed, it has a certain relation to vapors. The fine specimens obtained when molten iron passes over moist earth, the metallic-like glazing of coke, and the lustrous residues of animal decomposition by heat, in presence of vapors, are all instances of the existing connection between vapors and this allotropic carbon.

"Taking a suite of specimens, the microscope enables us to see, in the early stages of deposition, that every part is vesicular; that mammillary forms result from the aggregation of the vesicles; and, pursuing these observations, we often find the broken vesicles filling vacant spaces between those more perfect, and a consolidation resulting from this arrangement. Where pendent parts exist, their sections show a perfectly regular building up from layers of sublimate, each layer being composed of vesicles, more or less broken; the thin shell of each exhibiting the superposition of layers which belongs to bubbles. The examination of hundreds of specimens will not show any departure from this character of a sublimate, produced either from its own vapor, or when transported by another kind of vapor. We find also that those coal carbo-hydrogens which afford most vapors are those which leave in their decomposition most allotropic carbon; the natural bitumens affording the most remarkable and convincing results in this way.

"As the mechanical state of the gas carbon, clearly shown under the microscope, as well as to the unassisted eye, is that of a solid left from a transporting vapor, observation indicates that it has been thus formed in the very compound atmosphere resulting from coal decomposition. It is a fact of chemical science, that olefiant gas, when heated, deposits carbon, and the fact can be easily demonstrated. But it is a remarkable feature in this decomposition, that the gas deposits its carbon in the form of *lampblack*, and the utmost reach of the means of control will not produce an aggregation of particles resembling charcoal. In high or comparatively low temperatures, the deposition *never has the state of allotropic carbon*, and, chemically speaking, *there is no evidence that this form of carbon can result from olefiant gas changes.* If, however, vapors of bitumen are mixed with the olefiant gas, these vapors suffer decomposition by heat, and we easily obtain in the mixture vesicular brilliant carbon in the allotropic state of gas carbon; while the vapors solely much more readily afford this substance, in form and composition closely resembling gas carbon.

"The subject, as I have studied it, appeared to possess interest in connec-

tion with the new facts which M. H. St. Claire Deville has lately published, respecting the graphitic form of Silicon, Boron, &c., in which a similarity of conditions of production is essential to the effect being obtained. In geological theory, the formation of anthracitic carbon in one case, and of graphite, with the gradations back to anthracite, in another, has hardly been explained; but if we are allowed to take the allotropic state of carbon as a distinctive character of that carbon, which has been sublimed, through the agency of its own, or more likely a foreign vapor, then the occurrence of these forms of carbon ceases to be anomalous, and accords with the circumstances under which many rocks have been produced. Graphite, graphitic carbon, graphitic oxide of iron, and, in general, sublimates composed of vesicular forms presenting laminæ, under this view become a class of bodies which owe their forms to the transporting power of vapors in motion.

"Another point observed in the decomposition of olefiant gas deserves notice. It is stated in most treatises on chemistry, and adopted as a matter of belief in the gas manufacture, that olefiant gas, when heated, deposits two of its four proportions of carbon, and, without change of volume, becomes marsh gas. It is barely possible, as an accidental circumstance, this proportion of carbon might be deposited, but it would take place, not as an experimental, but as a chance result. When olefiant gas is passed through ignited quartz, glass, or iron-turnings, it deposits carbon, *which has no definite relation to the composition of the gas*, a mixed gas being left, containing olefiant marsh gas and hydrogen. If the gas is repassed, the carbon may be nearly all abstracted, the marsh gas suffering decomposition.

"The conditions of olefiant gas heated in the products of coal decomposition are not such as to lead to a breaking up of its carbon arrangement, for there are many reasons for the statement, that this bicarburet is itself the result of change in the vapor of paraffine and other hydrocarbons of the oily characters.

"It seems, therefore, a correct deduction from observation and experiment, that gas carbon is not produced from olefiant gas by deposition, but is a product of changes caused by heat in vapors of hydrocarbons, and that this allotropic carbon, in other cases, forms in the presence of vapors, which can transport carbon in the vesicular state."

ON THE EXISTENCE OF SILVER IN SEA-WATER.

MM. Malaguti, Durocher and Sarzeand, French chemists, some years since detected and estimated the amount of silver in sea-water. They had suspected its existence and obtained it by passing sulphuretted hydrogen through large quantities of water, and also by fusing the salts obtained on evaporation with litharge and subsequent cupellation.

According to the results obtained, a cubic mile of sea-water was estimated to contain ten pounds and three-quarters of silver. Analyses by the same chemists, of marine plants, gave confirmatory results. The silver, however, being present in larger quantity.

As a solution of chloride of silver in chloride of sodium is instantly

decomposed by metallic copper, chloride of copper being formed and silver precipitated, it appeared to Mr. Frederick Field, an English chemist, resident in Chili, highly probable that the copper and the yellow metal (Muntz's) used in sheathing the hulls of vessels, must, after long exposure to sea-water, contain more silver than they did before having been exposed to its action, by decomposing chloride of silver in their passage through the sea, and depositing the metal on their surfaces. He soon had an opportunity of testing the correctness of his surmise. The *Ana Guimaraens*, a large vessel under the Chilian flag, was hauled down to be repaired near Coquimbo, where Mr. Field resides, and a few ounces of yellow-metal sheathing from her bottom were obtained for analysis. The investigation was interesting, as the metal had been on for more than seven years (an unusually long period), and the ship had been trading up and down the Pacific Ocean all that time. The metal, upon examination, was found to be exceedingly brittle, and could be broken between the fingers with great ease. Five thousand grains were dissolved in pure nitric acid and the solution diluted; a few drops of dydrochloric acid were added and the precipitate allowed to subside for three days. A large quantity of white insoluble matter had collected by that time at the bottom of the beaker. This was filtered off, dried, and fused with one hundred grains pure litharge, and suitable proportions of bitartrate of potash and carbonate of soda, the ashes of the filter being also added. The resulting button of lead was subsequently cupelled, and yielded 2·01 grains silver, or 1 lb. 1 oz. 2 dwt. 15 gr., troy, per ton. This very large quantity could hardly be supposed to have existed in the original metal, as the value of the silver would be well worth the extraction. It is to be regretted that none of the original sheathing had been preserved, but a sample of ordinary yellow metal, yielded only 18 dwt. to the ton.

A short time after, however, the captain of a brig, which had just arrived in the Pacific from England, gave to Mr. Field a piece of Muntz's yellow metal from his cabin, from the same lot with which the brig was sheathed, but which had never been in contact with salt water, and also a small portion from the hull of the ship, after it had been on nearly three years. The experiments were performed as before, and the results were very striking:—

Grs.	Gr.		Oz.	dwt.	grs.	
1,700 from cabin gave........	·051 =	·003 per cent......=	0	19	14	per ton.
1,700 from hull gave...........	·400 =	·023 " ......=	7	13	1	"

That which had been exposed to the sea having nearly eight times as much silver as the original sample.

Many other specimens were examined of metals from the bottoms of ships, and of pieces which are always kept on board in case of need, and it was invariably found that the former contained more silver than the latter. For instance, a piece from the hull of the Bergmann, gave 5 oz. 16 dwt. 18 gr. per ton, while that from the cabin yielded 4 oz. 6 dwt. 12 gr. Two hundred grains from a piece from the hull of the Parga gave ·072 gr., and a piece of fresh metal ·050 gr.; while from the Grasmere, only coppered a few months,

610 gr. from the hull gave ·075 gr., and from the cabin ·072 gr., a very slight difference indeed.

It will be observed that the amount of silver in the above specimens of fresh metal is very high, and it is probable that most of these are merely the re-rolling of masses of metal melted down from the old sheathing, and have derived the greater part of their silver from the sea on former occasions. It is well known that the copper used in the manufacture of yellow metal is very pure, containing 2 or 3 dwts. of silver per ton, frequently not so much, and silver is very seldom associated with the other constituent, zinc.

To arrive at more certain results, Mr. Field has granulated some very pure copper, and reserving a portion in glass, has suspended the remainder (about ten ounces), in a wooden box perforated on all sides, a few feet under the surface of the Pacific Ocean. When occasion offers, the box is towed by a line at the stern of a vessel which is trading up and down the coast of Chili. The result of this experiment, when obtained, is to be forwarded to the London Chemical Society.

M. Piesse, of London, as the result of experiment, ascribes the beautiful blue color of the Mediterranean Sea to an ammoneacal salt of copper, and the greenness of other seas to chloride of copper. His experiments were performed between the ports of Marseilles, on the French Mediterranean coast, and Nice, in Sardinia. A bag of nails and scrap-iron was suspended at the side of the steamer which plies between these places, and after the first voyage (about twelve hours), copper was indicated to be present on the iron. Four separate voyages, however, were made before the bag of iron was removed to the laboratory; then the quantity of copper was found to be so great that much surprise was shown that the presence of this metal had not been previously discovered, especially when the action of sea-water on ship's bottoms has long been known.

ON SOME PHENOMENA IN CONNECTION WITH MOLTEN SUBSTANCES.

Mr. J. Nasmyth, in introducing a paper on the above subject, to the attention of the British Association, stated that his object in so doing was to direct the attention of scientific men to a class of phenomena which although in their main features may be familiar to practical men, yet appeared to have escaped the attention of those who were more engaged in scientific research. The great fact which he desired to call attention to is comprised in the following general proposition, — namely, that all substances in a molten condition are specifically heavier than the same substances in an unmolten state. Hitherto water has been supposed to be a singular and special exception to the ordinary law, — namely, that as substances were elevated in temperature they became specifically lighter, that is to say, water at temperature 32 deg., on being heated, does, on its progress towards temperature 40 deg., become more dense and specifically heavier until it reaches 40 deg., after which, if we continue to elevate the temperature, its density progressively decreases. From the facts which Mr. Nasmyth brought forward, it appears that water is not a special and singular exception in this respect, but

that, on the contrary, the phenomenon in relation to change of density (when near the point of solidification) is shared with every substance with which we are at all familiar in a molten state, so entirely so, that Mr. Nasmyth felt himself warranted in propounding, as a general law, the one before stated, — namely, that in every instance in which he has tested its existence he finds that a molten substance is more dense, or specifically heavier, than the same substance in its unmolten state. It is on account of this that if we throw a piece of solid lead into a pot of melted lead, the solid, or unmolten metal, will float in the fluid, or molten metal. Mr. Nasmyth stated, that he found that this fact of the floating of the unmolten substance in the molten holds true with every substance on which he has tested the existence of the phenomenon in question. As, for instance, in the case of lead, silver, copper, iron, zinc, tin, antimony, bismuth, glass, pitch, rosin, wax, tallow, &c.; and that the same is the case with respect to alloys of metals and mixtures of any of the above-named substances. Also, that the normal condition as to density is resumed in most substances a little on the molten side of solidification, and in a few cases the resumption of the normal condition occurs during the act of solidification. He also stated that, from experiments which he had made, he had reason to believe that by heating molten metals up to a temperature far beyond their melting point, the point of maximum density was, as in the case of water at 40 deg. about to be passed; and that at such very elevated temperatures the normal state, as regards reduction of density by increase of temperature, was also resumed, but that as yet he has not been able to test this point with such certainty as to warrant him to allude further to its existence. Mr. Nasmyth concluded his observations by stating, that he considered this to be a subject well worthy of the attention of geologists, who might find in it a key to the explanation of many eruptive or upheaving phenomena which the earth's crust, and especially that of the moon, present, — namely, that on the point of solidification molten mineral substances then beneath the solid crust of the earth must, in accordance with the above-stated law, expand, and tend to elevate or burst up the solid crust, — and also express upwards, through the so cracked surface, streams more or less fluid of those mineral substances which we know must have been originally in a molten condition. Mr. Nasmyth stated, that the aspect of the lunar surface, as revealed to us by powerful telescopes, appeared to him to yield most striking confirmation of the above remark. He concluded by expressing a hope, that the facts which he had brought forward might receive the careful attention of scientific men, which their important bearing on the phenomena in question appeared to him to entitle them to.

A gentleman in the section asked Mr. Nasmyth whether the facts well known to chemists, that cast iron, and one or two other metals, in the act of solidifying enlarged so as to fill out sharply the minute parts of the mould — which was indeed the property on which their great use chiefly depended — were not at variance with his general principle. Mr. Nasmyth replied, that, so far from that, they were the most striking examples of its application.

ON SOME GENERAL METHODS OF PREPARING THE RARER ELEMENTS.

M. Deville has lately published some interesting memoranda upon the subject which is now attracting so much attention in France and Germany, the preparation of the rarer metals. Deville is of opinion that the best mode of preparation consists in igniting the oxide with carbon, taking care to employ an excess of oxide. It is however an indispensable precaution to fuse the metal in a crucible of lime or magnesia. Crucibles of clay, porcelain, &c., are like borax partially reduced by many metals and even by platinum. The silicon produced considerably increases the hardness and fusibility of the metal. In a crucible of lime the oxide of chromium or manganese in excess is absorbed by the lime, forming a chromite or manganite which fuses with great difficulty, but which removes from the metal all traces of carbon and silicon. The fusibility of the metal diminishes as its purity increases, and the author found chromium less fusible than platinum. Deville remarks that manganese, as prepared by Brunner's method, may still contain carbon. Sodium prepared from the carbonate always contains more carbon, and moreover, from its porosity it frequently retains naphtha, which leaves a carbonaceous residue when heated. The employment of Hessian crucibles is also objectionable, as silica is easily reduced by sodium, especially in the presence of the fluorids. In this manner the author explains the differences between Brunner's manganese and that prepared by himself, which is less fusible than iron, and decomposes water at ordinary temperatures. The employment of sodium, on the other hand, presents great advantages when we wish to obtain an element in a crystallized state. In this case the sodium may often be replaced by aluminum, as for example, in preparing silicon, titanium, zirconium, and boron. In the case of the sesquichlorids of zirconium, aluminum or chromium, it is always well to make the sodium react upon the double chlorids which these bodies form with chlorid of sodium. The process should be conducted in a crucible of alumina which is to be heated to redness before putting in the mixture of chlorids. In the case of the fusible metals it is well to add to the whole a little double chlorid of sodium and potassium. Deville and Damour are now applying this process to the cerium metals. Sodium attacks porcelain at a low red heat with such energy that there is always danger of introducing silicon into metals reduced in such vessels. This perhaps explains the difference between the properties of chromium as prepared by Frémy and that prepared by Deville and Bunsen, the latter being readily soluble in chlorhydric acid giving a blue solution of the protochlorid. In conclusion, the author again recommends the employment of crucibles of lime which refine the metals fused in them. The platinum metals fused in such crucibles present properties very different from those usually attributed to them, the lime serving to deprive them of osmium and silicon. — *Comptes Rendus*, xliv, 673, *March 30th*, 1857.

THE METAL MAGNESIUM.

MM. Deville and Caron, have communicated to the Comptes Rendus the following information respecting the Metal Magnesium:

The chemical properties of magnesium have been determined with extreme perfection by M. Bussy, to whom we owe the discovery of this metal. There exists, however, in this metal a physical property which has, as yet, been overlooked; it is a new fact in which it resembles zinc, to which it was already so closely allied. Magnesium is volatile like zinc, and nearly at the same temperature. Thirty grammes (about one ounce) have been distilled easily at a time. When the magnesium is pure it leaves no residue, and the sublimed metal is white, surrounded with a small quantity of oxide. When it is impure it leaves a certain amount of very light black matter of a complicated nature, and then the distilled magnesium is covered over with small needle-shaped crystals, which are colorless and transparent, and which soon decompose of their own accord into ammonia and magnesia; this action indicates the probable existence of a nitrid of magnesium, analogous to those remarkable bodies which Wohler and Rose have already discovered in a certain number of simple bodies.

Magnesium fuses at a temperature close approaching that at which zinc fuses. At a little higher temperature it burns with a dazzling flame, in the midst of which can be observed, from time to time, tufts of an indigo blue tint, more especially if it is burned in a jet of oxygen. The combustion of the magnesium is accompanied with all the phenomena observed in the combustion of zinc, and which denote a volatile metal, of which the oxide is fixed and infusible.

The density of magnesium was found to be equal to 1·75; it can be filed very well, and burnishes beautifully; it keeps very well in the atmosphere when it is pure and its surface polished, but is scarcely equal to zinc in this respect.

Six hundred grammes of chloride of magnesium, prepared by the ordinary process, but with great care, are mixed with about one hundred grammes of chloride of sodium, which has been previously fused, or a mixture of the chlorides of sodium and potassium and one hundred grammes of pure fluoride of calcium; these are all in powder. To these are added, in small pieces, one hundred grammes of sodium, and the whole, mixed intimately, is thrown into an earthenware crucible at a red heat, and afterwards covered with a lid. In a short time the action begins, and when the noise ceases the crucible is uncovered, and the melted mass stirred by means of an iron rod until it appears homogeneous; globules of magnesium are now observed, and the crucible is taken from the fire to cool. When the saline mass is about to congeal it is again agitated, and all the small particles of metal spread over it are gathered together by means of the iron rod, and formed into one piece, which is drawn on a plate of iron. The scoria or slag may be fused over again, once or even twice, and each time a small quantity of the metal is obtained from it. Six hundred grammes of chloride of magnesium acted

upon by one hundred grammes of sodium has yielded forty-five grammes of magnesium.

The crude magnesium is introduced into a hallow vessel coated with charcoal, and this again is placed in a tube likewise coated with charcoal, and the whole brought to a lively red, almost white, heat, while a stream of hydrogen gas is made to pass slowly through the tube, which is inclined downwards in the furnace; all the magnesium condenses just beyond the hollow vessel, and is gathered easily when the tube is cold. It is afterwards fused in a mixture of the chlorides of magnesium and fluoride of calcium.

In distilling magnesium, if the current of hydrogen is too strong, a little metallic powder is carried out of the apparatus along with the hydrogen gas. If this is ignited, it burns with one of the most beautiful flames it is possible to imagine, and this experiment would make a charming exhibition for a lecture room.

PREPARATION AND PROPERTIES OF METALLIC MANGANESE.

Brunner has recently published the following results of an investigation of the properties and preparation of the metal manganese:

The reduction of manganese is obtained as follows: An earthen crucible (a Hessian one) is half filled with alternate layers of fluoride of manganese and of metallic sodium, cut into plates from one to two lines in thickness, in the proportion of two parts of the former to one part of the latter by weight; the whole is then gently tapped, in order to leave as few interstices as possible, and covered with a layer of anhydrous chloride of sodium nearly half as thick as the mixture, and over this a layer of fluoride of calcium (fluor spar) in pieces as large as a pea. This latter substance is for the purpose of preventing the mixture from being projected out of the crucible, a rather violent reaction being always the result.

The crucible, thus charged and covered with a lid, is placed in a forge or blast-furnace, and heated gently, and for some considerable time; before the reddening of the crucible the reduction has taken place; this is indicated by a whistling noise in the interior of the mass, and a yellow flame rising above the crucible; at this point the heat is augmented, and carried to a reddish white. The whole is kept at this temperature for about a quarter of an hour, and left to cool by shutting up all the openings into the furnace. On breaking the crucible the metal is found in one piece at the bottom. The theoretical quantity of the metal is never obtained. The analysis of the fluoride gives in the composition Mn H, from this 100 parts of sodium ought to decompose 203·5 parts of the fluoride of manganese to form 183·5 parts of fluoride of sodium, and to furnish 120 parts of manganese. However, we ought to be contented with little more than the half.

Manganese thus prepared possesses properties essentially different from those which have been commonly attributed to it. Its color is that of some cast iron: it is brittle, and does not flatten out to the hammer, or to other mechanical forces; it is very hard, and not scratched by a file;

on the contrary, it turns the edge of the best tempered files. It is capable of the very best polish. At the ordinary temperature it is unalterable in moist or dry air: polished plates have been kept during two months in the atmosphere of the laboratory, charged throughout with moisture and other vapors, without the polish having suffered. Heated upon a slip of platinum it approaches closely in color to steel, passing afterwards into a brown, by covering itself with a coating of oxide.

Its specific gravity has varied in different trials from 7·138 to 7·206. It is not attracted by the magnet, and even when in a state of powder, exerts no influence upon the magnetic needle. Acids attack it rapidly. It dissolves easily in dilute sulphuric acid at the ordinary temperature. Nitric acid dissolves it rapidly, so does hydrochloric acid, even when much diluted with water, and likewise acetic acid.

There cannot be a doubt that manganese, prepared in this manner, will find applications in manufactures. The great hardness of this metal fits it for mechanical use. Set at a sharp angle, it can advantageously be substituted for the diamond in cutting glass, and even in the polishing steel and other metals. It is so susceptible of polish as to appear applicable for the purposes of optical instruments; for instance, the mirrors of telescopes. Although it cannot be forged, it can be rolled into shapes as easily as the cast iron. In fine, the alloys of this metal are capable of yielding useful substances; and the attention of manufacturers are now called to this subject. It is an established fact, that all steel contains small quantities of manganese. It has also for a long time been considered indispensable to add substances which contain this metal to the powder used for the purposes of cementation employed in making steel. The valuable variety of steel, known under the name of Wootz, owes, perhaps, its properties to *the addition* of manganese.

CRYSTALLIZED CHROMIUM AND ITS ALLOYS.

BY M. FREMY.

The result of my researches was to examine, comparatively, iron, manganese, and chromium, which form, as chemists are aware, a true chemical family amongst themselves, and to determine the influences which can, according to their mode of preparation, vary the properties of these metals and that of their alloys.

I have ascertained, in the beginning, that manganese and chromium are obtained in an absolute state of purity when the anhydrous chlorides of these metals are submitted to the vapor of sodium. The decomposition is effected in porcelain tubes, which are heated to redness, and the vapor of sodium, introduced by means of a current of hydrogen, re-acts upon the chlorides of the metals, which are placed in little nests or crucibles. Under the influence of the alkaline chlorides that are formed in the reaction, as well as by the agency of the current of gas, the reduced metals assume regular crystalline forms.

The chromium, which has particularly attracted my attention, presents itself in crystals, which shine with a great lustre when they are free, by

washing them from the alkaline chloride with which they are found mixed. These crystals have been examined and recognized as belonging to the cubic systems.

Chrystals of chromium are so hard, and have the curious property of resisting the action of the strongest acids, and even that of nitrohydrochloric acid. It is remarkable to observe chromium, which resembles in every other respect manganese and iron, behaving itself like rhodium and iridium in the presence of concentrated acids. These facts meet those of M. Deville, recently established in his researches upon aluminum, demonstrating that amongst some of the elements we fail to establish a natural classification.

It appeared interesting to study the alloys which chromium can form with other metals, and it has been observed that these alloys present often the hardness of the chromium, and resist, like it, the action of concentrated acids. I have obtained the alloy of chromium and of iron, either by reducing by carbon the chromate of iron, or in heating in the fire of a forge iron and oxide of chromium pure. This alloy crystallizes in long needles, which are very hard, and scratch substances the most hard, even tempered steel.

In examining into the conditions which are most convenient in preparing the alloys of chromium, I have observed that the green sesqui-oxide of chromium can be easily fused by the heat of a forge, and is changed into a black crystalline mass, which has all the characters of the crystallized sesqui-oxide of chromium, obtained by decomposing chloro-chromic acid by heat. This oxide can be obtained in considerable masses; it scratches quartz easily, as well as tempered steel. It, as well as the alloys of chromium, ought to have some application in the arts.

TUNGSTEN AND ITS COMPOUNDS.

The following paper by M. Riche, is derived from the Annalen des Chemie, v. i. p. 5.

Many processes have been proposed for the preparation of the metal tungsten, but the process which ought to be employed is the reduction of tungstic acid by hydrogen gas.

If dry hydrogen gas be passed through a porcelain tube containing tungstic acid, heated to redness for at least two hours, a substance is obtained which contains no oxygen, and which is the metal in a high state of purity, provided the tungstic acid had been carefully prepared.

It is an error to suppose that a higher temperature than what glass can support is not required; on the contrary, it ought to be very high, without which the tungsten contains always a certain quantity of the lower oxide, and does not present itself with the gray tint and crystalline appearance which always characterizes it when in a state of purity.

A modification of this process has been recommended, which consists in substituting bitungstate of potash for the tungstic acid. The reduction is more easy; however, for several reasons, it is not so valuable as the former process.

Another process was tried; it was that which lately has so well succeeded with Wohler and Deville; its principle is to act upon chloride of tungsten by means of the metal sodium.

The first experiments were made with the red matter, known under the name of chloride of tungsten; its vapor was passed over the sodium, heated in a glass tube filled with hydrogen; the reaction took place, and a brilliant metallic matter deposited itself on the tube, but in very small quantity, whilst a large quantity of water was disengaged, although every precaution had been taken to dry the hydrogen; this led to the belief that the supposed chloride was an oxichloride, and a true chloride was prepared and passed over the sodium as before, when only small quantities of a substance in brilliant plates coated the tube, but there was formed an abundant brown powder, which was purified by washing. This is pure tungsten, but without the lustre of the metal reduced by hydrogen from tungstic acid.

According to some experimenters, the atomic weight of tungsten has been represented by ninety-six, and by others at ninety-two, but there is every reason to believe that this last number is even too high, because it is obtained by operating upon tungstic acid prepared by means of carbonate of soda, which invariably retains traces of the alkali; besides, the tubes in which the reductions were effected were not heated high enough. In this case the tungstic acid was prepared by acting on the mineral wolfram at once with nitro-hydrochloric acid, and supersaturating the acid solution with ammonia, which gives a tungstate perfectly crystallized. After a second crystallization the salt is calcined, and leaves the tungstic acid fit for the experiment. Five results were obtained, and the tungstic acid considered of the formula $Tg\ O^{3}$ gave the atomic weight of tungsten as eighty-seven. These experiments were confirmed by operating upon tungstic acid prepared in a different manner.

Tungsten obtained by the action of tungstic acid or hydrogen is in small very sharp crystalline grains, isolated from one another, brilliant, susceptible of taking a beautiful polish when rubbed, and scratching glass with facility; placed in the fire of a forge so powerful as to alter the shape of the crucible, they do not melt. A very powerful Bunsen's battery was required to melt tungsten, a very notable portion of the metal became oxidated and burned with a bluish green flame resembling zinc under similar circumstances. It melts similarly and very quickly in a jet of oxygen and hydrogen; but still the greater portion of the metal oxidates and disappears in fumes of tungstic acid. The density of this melted metal is 17·2. Experiments were made to manufacture it in a similar manner to platinum; but even the most skilled workers in platinum failed in attempting it. Oxygen, dry or moist, at the ordinary temperature, does not affect it, even after being in contact with it eight months; but at a temperature of redness it burns and yields tungstic acid free from the lower oxides; in air the heat ought to be stronger, but the result is the same. Sulphur in a state of fusion does not exert a rapid action upon it. At ordinary temperatures it does not burn in dry chlorine gas, but at 250 to 300 degress Fah., if air and moisture are carefully excluded from the apparatus, it forms chloride of tungsten $Tg\ Cl^{3}$.

Carbon unites with tungsten with great facility. The presence of carbon was determined in a few grains of the metal that had been melted in charcoal; it causes the metal to become brittle. Boiling water, distilled water, or ordinary water, do not attack it even at the end of many months; all that can be remarked is, that the metal is slightly tarnished at the surface, but there are no traces of the blue oxide formed. With dilute solutions of the alkalies, the metal, instead of tarnishing, remains quite bright; but in time there is observed a small quantity of tungsten in solution. This action, so slow under these conditions, becomes rapid enough if a concentrated and boiling solution of potash be employed. Nitric acid heated changes this metal into tungstic acid; this action is not terminated until after some days, whilst it is accomplished immediately with aqua-regia. Sulphuric and hydrochloric acids attack it but slowly; nevertheless it is attacked, for the blue color of the liquid soon becomes manifest.

CHEMICAL CHARACTER OF TUNGSTEN.

More recent researches of M. Riche, superintendent of the Chemical department of the Faculty of Sciences at Paris, establish the position of tungsten in the series of simple bodies. According to him it is a metalloid rather than a metal; and he concludes that although differing in some characteristics from boron and silicon, *it should be arranged along side of these metalloids.*

INTERESTING RESEARCHES ON BORON.

MM. Wöhler and Deville have recently published the results of some interesting researches on Boron, from which it appears that this substance can exist in three states, exactly corresponding to those of carbon — the amorphous, the graphitic, and the crystallized state. The preparation of crystallized boron is as follows: eighty grammes of aluminum in thick pieces are fused in a crucible of carbon with one hundred grammes of fused and pulverized boric acid. The carbon crucible is placed in one of graphite, the interstices being filled up, and the whole heated in a wind furnace to the temperature at which nickel melts, for five hours. The mass is then left to cool, and, on breaking the crucible, two distinct strata come to view, one consisting of vitrified boric acid containing some alumina; and the other of aluminum in a metallic state, mixed up with crystals of boron. To separate the latter, this metallic mass is treated with boiling caustic soda to dissolve the metal; then with boiling hydrochloric acid to dissolve the iron which may have been separated from the plumbago of the crucible; and lastly, with a mixture of nitric and hydrofluoric acid, to dissolve the silicum left by the soda. After this, the boron will be obtained crystallized in complicated aggregations of numerous small crystals the form of which has not yet been determined. These crystals are sometimes garnet-red, and sometimes honey-yellow; the color however does not appear to be essential, and may arise from slight impurities. The crystals have a lustre and refractive power like that of the diamond. They scratch corundum with the greatest ease, and appear to be

almost, if not quite as hard as the diamond itself. Crystallized boron resists the action of oxygen even on strong heating, but at the temperature at which diamond burns, boron oxydizes superficially. Chlorine acts powerfully on boron, which takes fire at a red heat in an atmosphere of the gas and burns to gaseous chlorid of boron. No acid acts upon boron, but acid sulphate of potash at a red heat reduces it, sulphurous acid being evolved. Hydrate and carbonate of soda oxydize it slowly at a red heat but saltpetre has no action at this temperature.

The graphitoid boron is best obtained by heating fluoborate of potassium with aluminum. Small masses of boron-aluminum are obtained, which on solution in muriatic acid leave the boron in small plates, often hexagonal and having the form and lustre of native graphite and graphitoid silicon. The plates are always opaque. Amorphous boron is best prepared by heating a small piece of aluminum with a large quantity of boric acid, purifying the product as above. It is a light chocolate-brown substance, possessing all the properties described by Berzelius, Gay Lussac and Thenard. The authors conclude that boron resembles carbon more closely than silicon.

ON SILICIUM AND THE METALLIC SILICIURETS.

Deville and Caron have presented to the French Academy a memoir upon silicium or silicon which exhibits many points of special interest. The authors find, in the first place, that aluminum is not the only metal which possesses the property of dissolving silicon, but that zinc may also be made to act advantageously as a solvent. The preparation of crystalline silicon by means of zinc is very simple and easy of execution. An earthen crucible is to be heated to redness and a carefully made mixture of three parts of fluosilicate of potassium, one part of sodium cut in small pieces, and one part of granulated zinc is to be thrown into it. The reaction ensuing is very feeble and not sufficient to effect the fusion of the mass. The crucible must therefore be kept at a red heat until the scoria is completely fused. The heat must not be high enough to vaporize the zinc, or the operation would be lost. After slow cooling, the crucible is to be broken, when a button of zinc will be found, penetrated through its whole mass, and especially on its upper surface, by long needles of silicon. These are groups of regular octahedrons imbedded in each other parallel to the axis which unites the summits of two opposite angles. To extract these crystals, it is only necessary to dissolve the zinc in chlorhydric acid, and then boil the silicon with nitric acid. In this way crystallized silicon may be obtained in more beautiful crystals, and in larger quantity, than by any other method. The only portion of silicon lost in this process, is that disengaged in the form of siliciuret of hydrogen at the moment of the solution of the zinc. If the alloy of zinc and silicon be heated beyond the point at which the metal volatilizes, the silicon remains in the state of a fused mass which is entirely free from zinc. Pure silicon may be fused and run into moulds. In this manner the authors prepared ingots which were presented to the Academy. The authors are now engaged in studying the alloys of silicon which appear to be of much interest. The

alloys with iron are very fusible, and in their physical properties resemble cast iron and steel. A very hard, brittle and white alloy of silicon and copper containing twelve per cent. of silicon is prepared by fusing together three parts of fluosilicate of potash, one part of sodium, and one part of copper turnings, till a very liquid scoria is obtained. An alloy of copper and silicon containing 4·8 per cent. of silicon possesses a beautiful clear bronze color. It is a little less hard than iron, and may be filed, sawed, or turned, like that metal. It is perfectly ductile, and wires drawn from it are as tenacious as those of iron. The hardness of the siliciurets increases with the quantity of silicon, but at the same time their ductility diminishes. They are all characterized by the fact that silicon is uniformly distributed throughout the mass so that the alloys are homogeneous and not susceptible of liquation. The authors presented to the Academy two small cannon made of alloys of copper and silicon. They furnish examples of what may be done in the arts by the application of the alkaline metals, and of the progress which is every day making in the manufacture of sodium. The authors have not limited their experiments to silicon, but expect by similar methods to prepare other simple or compound bodies in a crystallized state.—*Comptes Rendus*, xlv, 163, *Aug.* 1857.

New Oxide of Silicon.—Wöhler has communicated to the French Academy of Sciences a brief notice of a new oxide and chlorid of silicon. While occupied with the study of the conducting power of aluminum for the galvanic current, Wöhler and Buff observed that when a plate of this metal is made the positive pole in a solution of chlorid of sodium, a gas is disengaged which takes fire spontaneously in the air. Supposing that the silicon contained in the aluminum had something to do with the phenomenon, the authors sought to prepare the gas by purely chemical means. By heating silicon to redness in a current of dry chlorhydric acid gas the acid was easily decomposed, hydrogen being evolved and a new chlorid of silicon produced. This is a fuming, very mobile liquid, more volatile than the ordinary chlorid, $SiCl_3$. It is decomposed by water in chlorhydric acid and a new oxide of silicon. This latter is a white matter, slightly soluble in water, and very soluble in alkali, even in ammonia, disengaging hydrogen gas with effervescence, and becoming converted into silicic acid. Heated in the air it takes fire and burns with a very white light, disengaging hydrogen, which takes fire. The authors are studying the constitution of the new chlorid and oxide. —*Comptes Rendus*, xliv, 834.

ON GOLD IN THE FORM OF MALLEABLE SPONGE.

Mr. D. Forbes recently described to the London Chemical Society the following process for converting gold into the form of a malleable sponge, suitable for employment for dentists in the place of the ordinary gold leaf.

Gold free from copper is dissolved in nitro-hydrochloric acid, keeping an excess of gold in the solution towards the close of the operation, so as to get rid of all nitric acid and avoid subsequent evaporation; any chloride of silver present is filtered off. The solution of gold is now placed in a flat-

bottomed vessel and heated, and a strong solution of oxalic acid added; in a few hours the whole gold is deposited, and the supernatant liquid may be decanted off, taking care all the time not to disturb the gold at the bottom, and the vessel is then several times filled up with boiling water and decanted until the last washings contain no more oxalic acid.

The gold is now carefully slipped on to a piece of filtering-paper, and by means of a spatula gently pressed into the form of the desired cake, but somewhat thicker; it is then removed to a porcelain crucible, and heated for a short time somewhat below a red heat, when it shrinks in dimensions, becomes coherent, and suitable for use. This process is essentially different from one patented and used in this country.

MANUFACTURE OF ALUMINIUM.

Dumas recently announced to the French Academy that the problem of rendering the preparation of aluminium an industrial operation has now been solved. The methods have been devised by MM. Deville and Morin, and differ but little from those originally employed. It is necessary always to decompose the chlorid of aluminium, and decompose it by sodium, in order to obtain the aluminium. The chlorid is now made by the direct use of kaolin, or even of clay. But this is not all. The chloride was difficult to manage in a large way, because, after having been formed in vapor, it was often condensed in snowy crystals, rendering it necessary to collect it in chambers, and detach it mechanically from the surfaces it coated. There was, *first,* a loss of the chlorid, the condensation being incomplete; *second,* danger for the workmen exposed to the respiration of the vapors; *third,* an enhancement of cost from the interruptions of the occupations. The improvement consists in submitting to a current of chlorine — no longer a mixture of alumina and charcoal, — but a mixture of alumina, charcoal and chlorid of sodium; this affords a double chlorid of aluminium and sodium, which is volatile and liquifiable, running like water, and becoming solid with cold. The preparation goes on uninterruptedly, proceeding with simplicity and regularity, and exacting no other care than what is necessary for the production of the chlorid, the renewal of the preparation for decomposition, and the substitution, as soon as cooled, of earthen pots, in which cakes form from the double chlorid that flows in in a continued stream.

The chlorid is decomposed in a reverberatory furnace, into which, mixed with bits of sodium, it is introduced. The reaction of the two substances takes place after a few moments, but so quietly that it may be done on a large scale without danger. It leaves the aluminium in plates, globules, or a powder. It is separated from the common salt either mechanically or by means of water.

Dumas asserts that the cost of making sodium is at the most seven francs a kilogram, and that its manufacture is easier than that of phosphorus and also as simple as that of zinc.

By acting on a mixture of carbonate of soda, carbon and chalk, the reaction is so complete that the result agrees with calculation, and so easy that we may substitute for the iron bottle commonly used, luted copper tubes.

In the manufacture of sodium the carbon is now replaced by coal. Deville uses a coal which burns with considerable flame. It is important that the mixture should be well dried before subjected to decomposition. The proportion used are as follows:

Carbonate of soda,..	30 kil.
Coal,..	13 "
Chalk,..	5 "

The soda ought to be from the crystallized carbonate; the soda of the shops gives bad results without Deville's knowing precisely why.

Mr. Newton (for a foreign correspondent) has also patented in England, a process by which the production of aluminium is reduced to an essentially practical and commercial form. It has hitherto been the practice to effect the reduction of aluminium from its different compounds (single or double chlorides or fluorides) in closed vessels, and in published descriptions on this subject it has been usual to mention the employment of crucibles enclosed in tubes or retorts of fire-clay, coated with alumina. As the employment of the apparatus is attended with disadvantages, the inventors have, in the first place, substituted for such apparatus vessels made of cast or wrought iron, of varying form but generally approaching that of crucibles, pots, or seggars, in which vessels, the reaction is effected in the same manner as in vessels of clay. The inventors of the present improvements have also succeeded in effecting the reduction in chambers made of brick-work or fire-clay, which may be either heated in the same manner as a reverberatory furnace, or by the transmission of heat through the sides. The apparatus employed by preference, however, is a reverberatory furnace, the bed of which, having a portion of it inclined, is arranged in a suitable manner for facilitating the collection of the metal as it is produced; but the furnaces ordinarily employed for the manufacture of soda may be used for this purpose. Another improvement consists in modifying the composition of the mixture or matters for effecting the reaction in such a manner as to ensure successful operation, even when operating upon small quantities of materials, or with vessels of small capacity, such as clay retorts or other closed vessels. This is effected by wholly, or to a great extent, dispensing with the marine salt, which is usually added either to the simple chloride of aluminium, the double chloride of aluminium and sodium, or to the fluoride of aluminium and sodium (cryolite), and in simply adding a suitable proportion of fluoride of calcium. The use of marine salt had been hitherto considered necessary for the successful performance of the reduction, and indispensable as a flux for causing the metal to unite; in operating with the double chloride of aluminium and of sodium it had been pointed out, and always employed in the proportion of fifty per cent. to the double chloride. It has been found by experience that by diminishing this proportion better results are obtained, and by dispensing with the marine salt altogether, the largest quantity of metal is obtained. The following is the mode of operating, according to this improvement, when it is required to effect the reduction of the double chloride: Take of the double chloride of aluminium and

of sodium, one hundred parts; fluoride of calcium, fifty parts; sodium, twenty parts. (These proportions may, however, be somewhat varied, according to circumstances.) These substances having been mixed together, are introduced upon the bed of the furnace, previously heated to redness. The fire bars having been well fed with fuel, the furnace is closed. The reaction will then take place, and by agitating the materials all the aluminium will be collected in a mass at the inclined part of the bed, and may be run off therefrom. By first pouring off the whitest and most fluid portion of the scoriæ, composed chiefly of the marine salt which has been produced by the reaction, the fluoride of aluminium (which is also an accessory product of the reaction) may also be extracted therefrom. The appearance of the scoriæ remaining is very peculiar, after cooling; it is slightly tinged with a color approaching a yellowish gray. This scoriæ does not contain the finely-divided aluminium powder which is met with when the reaction is produced with marine salt; it only contains sometimes globules of aluminium, in sufficient quantity to enable it to be collected by pulverizing and washing the mass. When, on the contrary, marine salt is employed, the mass of scoriæ is of a decided deep gray color; this arises from the aluminium powder mixed with the mass, in which are found only microscopic globules, which are at first difficult to collect, and unite by melting.

An additional method of producing aluminium has also been recently brought out in England. It consists in placing fluoride of aluminum in an iron oven, which may be heated in various ways. This oven is first strongly heated, and on the floor thereof is placed a number of shallow dishes. A number of these dishes are filled with dry and well-powdered fluoride of aluminum, and the remainder with iron filings. They are so arranged that all of those dishes which contain the fluoride are on all sides surrounded by dishes containing the iron filings. The oven is then closed and luted, and the heat increased to redness, after which a stream of dry hydrogen gas is introduced. The effect produced is, that the hydrogen gas combines with the fluorine, and forms hydrofluoric acid, which acid is taken up by the iron, and is thereby converted into fluoride of iron, whilst the resulting aluminum remains in the metallic state in the bottom of the trays containing the fluoride.

ALLOYS OF ALUMINIUM.

MM. C. and A. Tissier find that the valuable properties of aluminium are injured by the presence even of small quantities of other metals. One-twentieth of iron or copper make it almost impossible to work the alloy, while one-tenth part of copper renders aluminium as brittle as glass. An alloy of five parts of silver with one hundred of aluminium works like silver, but is harder, and takes a finer polish. The one-thousandth of bismuth renders aluminium so brittle that it cracks under the hammer, even after being repeatedly annealed. The presence of aluminium in other metals often communicates valuable properties when the quantity is not too large. Thus one twentieth part of aluminium gives copper a beautiful gold color and hardness enough to scratch the standard alloy of gold employed for

coins, whilst at the same time injuring the malleability of the copper. One-tenth of aluminium gives with copper a pale gold-colored alloy of great hardness and malleability, and capable of taking a polish like that of steel. Five parts of aluminium with one hundred parts of pure silver give an alloy almost as hard as silver coin containing one tenth of copper, and thus permits us to harden silver without introducing a poisonous metal. — *Comptes Rendus,* xliii, 885.

Debray has also communicated the results of experiments on the alloys of aluminium, apparently more numerous and varied than those of MM. Tissier.

According to this authority it forms alloys with most metals, and in most cases the combination takes place with great evolution of light and heat. An alloy of ten parts of aluminium and ninety parts of copper possesses greater hardness than ordinary bronze, and is worked when hot with more ease than the best soft iron. As the proportion of aluminium increases, the alloys generally become harder; they become brittle beyond very narrow limits with gold and copper. These metals also lose their color, and soon become completely colorless. Aluminium becomes more brilliant and a little harder, still remaining malleable, with small proportions of zinc, tin, gold, silver, and platinum. Iron and copper do not greatly injure the properties of aluminium if they are not in too great quantities; one or two per cent. of sodium, on the contrary, forms an alloy which readily decomposes cold water. For practical purposes, it is unnecessary that aluminium should be entirely deprived of iron. Metal reduced from impure chlorides, but of which the malleability and tenacity differed but little from those of pure aluminium, contained seven to eight per cent. of iron. The union of the two metals takes place with facility; the iron pokers with which the liquid baths are stirred in the furnaces where aluminium is produced become covered with a brilliant layer of this metal. Aluminium contaminated with iron is purified by a simple fusion in nitrate of potash. M. Debray alloyed five parts of aluminium with ninety-five parts of iron, without imparting to the latter properties very different from its own. An alloy of zinc containing ninety-seven of aluminium and three of zinc is a little harder than the metal; although very malleable, it is equal in brilliancy to any other alloy of aluminium. Aluminium may contain ten per cent. of copper without losing its malleability, which is diminished, however; the metal reduced in copper trays contains from five to six per cent.; it is also worked with facility. With ten per cent. it becomes brittle, but remains white as long as the proportion of copper does not exceed 80 per cent. The alloy thus obtained is white and brittle, and resembles the metal of telescope mirrors. The alloy with eighty-five per cent. of copper is still brittle, but begins to grow yellow. The copper probably loses its color when it is below eighty-two per cent., which corresponds with $Cu^2 A^1$. The aluminium bronze already mentioned unites with the property of being forged when hot, that of great unalterability in the presence of hydrosulphate of ammonia. Its yellow color is fine, but inferior to that of the alloy of ninety-five copper and five aluminium. An alloy of three parts silver and ninety-seven aluminium has a very fine color,

and is unalterable in presence of sulphuretted hydrogen. One part of aluminium and one part of silver give a material as hard as bronze. An alloy of ninety-nine gold and one aluminium is very hard, but malleable; its color is that of green gold. The alloy of ten aluminium is colorless, crystalline, and consequently brittle.

ARTIFICIAL WHITE SAPPHIRES.

Some ten years ago, the late M. Ebelman, then director of the government Porcelain Manufactory at Sèvres, succeeded in crystallizing alumina by slowly evaporating a solution of this substance in boracic acid, by the heat of his furnaces. The crystals thus produced were microscopic but possessed all the properties of the sapphire, ruby, &c., except the color. A few years after, Mons de Senarmont obtained crystals of alumina and of silica, by exposing closed glass tubes, containing water and hydrates of alumina and silica, to a temperature of 180 deg. centigrade. The heat drove off the water from these earths, and converted them into insulated, anhydrous, and microscopical crystals, of rare beauty, and quite perfect.

M. Gaudin, in a communication made during the past year, to the French Academy, states that during the last twenty years he has directed his attention to the production of precious stones, but more particularly to rubies, and that he had succeeded in making rubies artificially by calcining ammonia-alum with the addition of five-thousandths of chromate of potassa, by the oxyhydrogen blowpipe — but that the large globules were deficient in limpidity, owing to partial crystallization.

Recent experiments have, however, proved more successful, and he has been enabled to obtain in a quarter of an hour, with a common forge fire, thousands of crystals, the size of which is proportionate to the volume and duration of the fire. For this purpose he proposes the following process. Into an ordinary crucible lined with lampblack, he introduces equal parts of alum and sulphate of potassa, previously calcined and powdered; the crucible is then submitted to a violent forge heat for a quarter of an hour. If the heat has been sufficient there will be found in breaking the crucible a small black concretion — sulphuret of potassium — covered with brilliant points — crystals of alumina. If this mass be placed in a capsule filled with acidulated water, and submitted to heat, the sulphuret will be dissolved out with effervescence, leaving at the bottom white sapphires, that at first sight appear like diamond powder. Under the microscope each grain appeared to be a crystal of marvellous limpidity.

Although coloring agents were introduced into the crucible, the sapphires have generally remained colorless, (owing to the reducing action of the carbon, which transforms all the coloring oxides into metallic globules), but in one experiment small colored crystals were deposited on the colorless crystals, and on one of the facets of a sapphire were found three hundred small rubies.

The greater the mass operated on, the larger the crystals. Those obtained by M. Gaudin were one mm. ($\frac{1}{20}$ in.) in length; and about one-third

thick. These are said to have proved upon trial, to be harder than the natural crystals, and therefore more fitted for mounting watches.

ON THE MANUFACTURE OF STEEL THROUGH THE AGENCY OF FERRO-CYANIDE OF POTASSIUM.

A company, under the name of the "Damascus Steel Company," has recently been formed, and commenced practical operations in New Jersey, for manufacturing steel through the agency, principally, of ferro-cyanide of potassium.

A recent writer in the New York Tribune gives the following account of the process, and the cost of the manufacture:— In small furnaces made of fire-brick and arranged in rows, the top being level with the floor, the crucibles are placed, two in each furnace, upon anthracite for fuel. This is kept in vivid combustion by a blower at the bottom. Each crucible holds sixty pounds of wrought iron, and the flux scatterred among the pieces. This consists of ferro-cyanide of potassium, (prussiate of potash), sal ammoniac and a little common salt, with which a few ounces of fine charcoal and a little black oxide of manganese are mixed. Their whole value for a crucible holding sixty pounds of metal is not more than eight cents. In the operation we lately witnessed 2,515 pounds of anthracite were consumed in melting twelve crucibles of iron, making the cost of fuel to the crucible fifty-eight cents. Each crucible costs one dollar, and lasts four heats, making the cost to sixty pounds twenty-five cents. Labor is estimated at sixteen cents to each melting of a crucible. Allowing the iron to cost $85 per ton, all the expense, beside superintendence, coal for the engine, which drives the blast, and general expenses, is for each crucible about $3.54. The steel produced weighs the same as the iron, the carbon taken up replacing the waste. Adding to the other items the cost of re-heating and drawing out the ingots into bars, the whole expense per ton of cast steel bars is about $142 for the same quality of steel we import at a cost of $300. The time required to melt the wrought iron is from three to four hours. In regular working, three heats have been run in nine hours. A curious fact has been observed in relation to the difference of time required to melt wrought iron derived from charcoal, pig, and that from anthracite pig iron, the latter requiring from thirty to forty minutes more than the former. There is no perceptible difference yet noticed in the qualities of the steel made from these irons. When lifted out from the furnaces the crucibles are taken to the ingot moulds, and the liquid metal is poured into them, precisely as is done in the melting and pouring of the blistered steel. This operation, therefore, involves no more labor and no more time than the simple melting part of the English method of making cast steel. The long *cementation* process is entirely done away with. The ingots, when taken from the moulds, are ready to be reheated for hammering or rolling, and these operations are conducted as in other steel works.

PRESENT STATE OF THE BESSEMER QUESTION.

It is only some few months since all Europe was standing on tip-toe, in expectation of witnessing a great and marvellous revolution in the manufacture of iron and steel, by a new and ingenious process, to which it is only necessary to allude in passing as that patented by Mr. Bessemer. It was something quite astounding to those who knew by what tedious and expensive means steel was produced from iron in the olden time, to be told that, by the new process, steel was the easier and cheaper production of the two. It was no less wonderful in the eyes of those who had considered iron as, at least in the open air, an incombustible, to be shown that it was, in fact, a highly combustible material; and that, if once heated by fire to a certain point, it might then, by strong air currents be actually *itself set on fire*, and made to burn with a fierce incandescence.

It is humiliating to think upon what small matters great ones often depend. There appears to be no reasonable doubt that Mr. Bessemer would have realized all he promised to accomplish but for one slight circumstance, which it is our intention now to explain, and the difficulty connected with which has, at least for the present, frustrated his expectations.

The subject of iron-founding has been so completely popularized by the discussions of this patent in the public press, that it will only be necessary for us to recall attention to the fact, that iron ore contains several foreign matters in intimate combination, and that upon their expulsion during the founding process depends the success of the ironmaster's work. These foreign bodies are chiefly carbon, silicon, sulphur, and phosphorus. The old methods of roasting, casting, refining, puddling, and rolling were found to effect the object in view sufficiently for all practical purposes. In Mr. Bessemer's process, all these substances, except phosphorus, are effectually expelled. It would seem that up to the present time this material has resisted all the efforts of Mr. Bessemer. It defies the utmost heat of his furnaces, and has no sufficient affinity for oxygen, or any other body brought in contact with it, to consent, for its sake, to let go its tenacious grasp of the iron. Now, phosphorus in iron is, as it appears, fatal to the useful qualities of the metal; it renders the iron brittle and unserviceable; and as no portion of it can be detected in the slag of the furnace, it would seem that, so far as its expulsion is concerned, Mr. Bessemer has as yet altogether failed. But it would surely not be at all philosophical to conclude that the question is finally set at rest, however serious the objection may be to which we have now called attention. It can hardly be too much to expect that in the resources of modern science some ingredient may yet be discovered, the results of which, in the instance before us, will be no less striking than those of soda, borax, and potash, when used as fluxes in various industrial operations. We should not be surprised any day to hear that some such depurgative had been discovered, and that its admixture with the incandescent iron in the furnace was found to detach the phosphorus, and leave the iron in a perfectly pure state. We wish we could go further than suggest the existence of some such drug, or metal, or mineral, whatever it may be. We sus-

pect that the man who could go farther than this, and supply Mr. Bessemer with its local habitation and its name, would participate largely in a most lucrative as well as scientifically honorable discovery.

We could ourselves easily indicate certain metallic combinations which, in dealing with phosphorus in its uncombined state, possess the power of neutralizing its caustic properties; but this may be far indeed from indicating a power in such preparations to deal with that wonderful substance as it is found in nature, united with the crude oxide of iron. Indeed, we take for granted that men of the highest mark in chemical science are just now eagerly devoting their attention to this interesting problem; and, as we have said, we look forward rather hopefully than otherwise to the result.

We are very far from participating in the triumph expressed by many at the partial, and, in truth, temporary failure in the expectations raised in the public mind by Mr. Bessemer and his discoveries; but it is still true that, up to the present time, the "revolution" has not come off. The new aspirants for dominion in the realms of metallurgy — we mean, of course, air-blast and oxygen — have not as yet been able to wrest the sceptre from the hand of "Old King *Coal.*" His carbonaceous majesty is still "master of the situation;" how long he may continue so, we by no means venture to take on ourselves even to conjecture.

In a recent discussion before the London Chemical Society on the various new processes of Bessemer, Martin, and others, for the manufacture of iron, Professor Abel remarked that of all foreign elements in the metal, the silicon was most readily and completely abstracted, both in the ordinary and in the newly proposed refinery processes. The primary effect of air when passed into the fluid metal is to oxidize a portion of the iron, the temperature of the mass being thereby raised and maintained; the silicon is simultaneously oxidated, and the graphite converted into carbide of iron; which last, after the attainment of a sufficiently high temperature, is decomposed by the air, and the carbon almost completely burnt off. It had been demonstrated by repeated experiments that treatment with air alone did not remove the sulphur or phosphorus to any important extent; the abstraction of these elements requiring prolonged contact with such agents as oxide of iron, as in the ordinary puddling process. This last process is consequently the only effective plan of purifying iron, but the circumstance of its efficiency depending chiefly on the skill and industry of the workman is alone sufficient to stimulate manufacturing energy to the production of a less laborious, more rapid, and equally efficacious method of freeing the metal from those foreign elements, whose presence detracts largely from its most valuable properties.

ELECTRIC GILDING, SILVERING AND PLATINIZING.

M. Laudois, of Paris, announces the preparation of a gold, silver and platina bath, having no deleterious exhalation, and capable of depositing solid coating upon the metals. M. L. dissolves a given weight of cyanide of gold, silver or platina, in a saturated solution of common salt; the solu-

tion is filtered and may be then used. The galvanic deposit takes place cold very rapidly, and the results are equal to those obtained by MM. Ruotz and Elkington.

RESTORATION OF ANCIENT BRONZES.

M. Chevreul has recently communicated to the French Academy a paper setting forth researches made by him on certain ancient bronze statuettes brought from Egypt. We take one example. He placed a small completely oxidated effigy of Anubis in a porcelain tube, filled the tube with hydrogen gas, and raised it to a dull red heat. Presently, water, colored green, was seen to condense in the bell glass, and after letting the apparatus cool, "I took out the statuette," he says, "completely revivified. I placed it before the eyes of the Academie, together with the water and chlorhydric acid which represent the oxygen and chlorine of Egypt, now transformed at Paris, by hydrogen, into water and acid."

ON THE PRODUCTION OF HEMATITE.

At a recent meeting of the Boston Society of Natural History, Dr. A. A. Hayes stated that he had proved, from careful analysis and examinations of pseudomorphs, as well as the more ordinary forms of hematite, that the infiltration of an aqueous solution of silicates of proto-peroxides of iron and manganese, *caused the production of hematite.* The beautiful black, glossy covering, which confers so much beauty on the ores of iron not truly hematites, as well as the ore of manganese, is always composed of silicate of proto-peroxide of iron, with silicate of one or both oxides of manganese; and the compact peroxides of manganese, often owe their density and hardness to this compound.

OREIDE—A NEW ALLOY.

Messrs. Mourier and Vallent, of Paris, have recently succeeded in forming an alloy which very closely resembles gold. The materials and proportions used by them are, pure copper, 100 parts (by weight); zinc, 17; magnesia, 6; sal ammoniac, 3·60; quick lime, 1·80; tartar, 9.

The copper is first placed in a crucible in a suitable furnace, and fused. the magnesia is then added slowly, then the sal ammoniac, lime and tartar separately and in the form of powder. These are kept from the air, and well stirred with the copper for twenty minutes, until the whole are incorporated together. The zinc is then added in strips or fine pieces, thrust through the crust on the top of the copper. The whole mass in then thoroughly stirred, the crucible closed, and its contents kept in fusion for twenty-five minutes. After this the crucible is opened, and skimmed very carefully to remove all the dross. The alloy thus formed is poured out into dry sand moulds if required to be rolled; if not, it may be poured into iron moulds. When remelted in a blast furnace, it is rendered more applicable for ornamental works of art.

This alloy, it is stated, is very beautiful, resembles gold in many respects, and may be used in a pure condition, or as a base for gold plating. Its cost is about eighty cents per pound, and yet its appearance is such that it would readily be taken for gold by most casual observers.

In France a law has already been passed to prevent frauds, by compelling under severe penalties for neglect, all manufacturers of "oreide" to stamp the word upon the articles produced.

Castings made of oreide are cleansed with an ordinary pickle of sulphuric acid and water to remove the oxide. The zinc may be replaced with tin, but it makes the alloy more brittle.

The manufacture of oreide has been recently commenced at Waterbury, Conn.

NEW ALLOY OF SILVER.

A new alloy, applicable for many purposes in place of silver, has recently been brought out in Paris. It is composed of silver, copper, and purified nickel, which metals may be combined in any suitable proportions; as silver, twenty parts; nickel, from twenty-five to thirty-one parts; and the rest up to one hundred parts in copper. An alloy is thus produced, containing twenty per cent. of silver, and constituting silver of the third degree of fineness, thus reversing the proportions of the ordinary compositions of the second degree. The copper employed must be the purest obtainable, and the nickel should be purified by some suitable process.

ON THE ORIGIN OF "CLAY STONES.

The following is an abstract of a discussion which recently took place in the Boston Society of Natural History, on the origin of the concretions found in clay, and familiarly known as "clay stones:"

Dr. C. T. Jackson considered the crystallizing force of the carbonate of lime to be the cause of the concretionary structure and form of these bodies, the foreign substances occasionally formed within them, serving as nuclei around which this semi-crystallization took place, the carbonate of lime aggregating and carrying with it the inert particles of clay, the spheroidal form being that which would result from this action when the force was not adequate to the production of crystals. He illustrated this view by reference to the spheroidal structure of hyallite and of various hydrous silicates, which form from a gelatinous paste, in which there is not sufficient freedom of motion to allow of the formation of perfect crystals. In case there were a larger proportion of carbonate of lime in solution as a bicarbonate, the crystalline forms would become more perfect, as in the well-known crystalline sand alone of Fontainbleau, in which grains of silicious sand are forced into the form of calcareous spar by the energetic segregation of the crystallizing carbonate of lime; the sand being inert matter which was forced by the calcareous salt to enter into the crystalline form of the spar.

Similar illustrations were adduced from chemical experiments and observations in which spheroidal forms result, and also in which foreign bodies

are forced to enter into the structure of crystals. He quoted the experiments of Beudant, which he had repeated, in which Prussian blue was included in crystals of nitre and alum. He also alluded to the effects of different menstrua, in modifying the forms of crystals or totally changing their forms, instancing the crystallization of sea salt in the forms of the regular octahedron in a solution of urea, whereas the cube is its usual form.

Dr. A. A. Hayes followed Dr. Jackson. Having inquired of Dr. J. how large was the proportion of sand in the Fontainbleau crystallized sandstone, and received for answer about fifty per cent., he said that he had often examined the spots where they were forming, and had noticed a growth equal to the size of a garden bean, to take place in the course of two or three weeks of wet, spring-time weather. To form a just conception of the conditions, the fact must be kept in view, that the beds containing them are composed of fine silts, and in the case immediately under view, these were arranged in planes of deposition of alternate courses, covered by much finer material, in layers of different thickness; so that the mass was stratified; the coarser layers being very permeable to water. The rounded forms, often strongly resembling organic remains, are found resting between these layers, and a condition necessary to their formation is, *the presence in the layer or rock above them of abundance of carbonate of lime.*

The force exerted by some salts in their tendency to crystallize is brought into view only when we study their formation, and carbonate of lime is one of the constantly-occurring salts which well illustrates, in a remarkable manner, this power of assuming regular forms. As has been stated, with fifty per cent. of its weight of *sand*, it forms regular rhomboids, but the more recent observations of some African travellers, who found their progress impeded by "stone plants," six or eight inches high, formed of aggregates of spear-shaped crystals of sand, cemented by carbonate of lime, show, that this large proportion may be exceeded, while the foreign material is in a somewhat *coarse state.*

In the formation of claystones, however, we are to consider the presence of finely-divided matter suspended in, or so mixed with water of infiltration in spring-time, or general saturation from position, that it has nearly a semi-fluid state. A saturated solution of bicarbonate, or more commonly crenate of lime, finds its way into the soft mass, by frost crevices, or channels left by roots, or even air-bubbles, and at these points the concretions commence, when no nuclei of similar chemical composition exist. The finely-divided matter interposes an obstacle to the formation of crystals of carbonate of lime, far greater than an equal amount of coarser foreign matter would do; and we observe, then, the influence of that beautiful law in accordance with which *rounded forms* are produced. In the laboratory similar forms daily occur, where the presence of finely-divided and diffused bodies arrests the formation of crystals, and globular, or curved-surfaced solids are produced; as in the animal frame, the cell-structure causes the dissolved phosphate of lime to take the curvilinear form pertaining to organization. The claystones which are produced under the simple conditions here described, have no con-

centric structure; a slight conformity to this structure being observed, when a bubble of air, or a vacant space, marks the point of commencing deposition. In other cases, a shell in its calcareous composition offers a preferred nucleus, and as it contributes its lime salt, a concentric arrangement may be noticed in the forms resulting, especially after exposing them to heat. Rounded massed once formed become centres, or nuclei of secondary occurring aggregates, one central mass being surrounded by spheres attached; but in all it is easy to read the influence of the tendency of carbonate of lime to crystallize, and the opposition of the finely-divided silt, causing the particles of both to assume forms without straight bounding lines, as the polarizing force of crystallization is arrested in all directions.

It may be added that a great number of bodies present rounded forms dependent on a modification of this law of restrained crystallization, such as numerous iron ores, bog manganese, and even the more compact forms, where infiltrated solutions, forming part of the material, existed at the moment of aggregation.

Dr. Hayes also made some remarks on the formation of macle crystals, the true theory of which he stated that he had many years since illustrated by numerous specimens and examples. Starting from the point where Beudant left the subject resting on a supposition, it occurred to him that the law was quite within the scope of a chemical demonstration, which would place this and similar instances of crystallization among known scientific facts. Without entering minutely into the matter, we may take as an example a salt exerting a strong tendency to crystallize from a hot solution on cooling, — ordinary saltpetre. A solution of this salt, in a pure state, slowly cooled, affords solid, six-sided prisms, or the crystals become solid if allowed to rest in the fluid, and we observe nothing but the result of ordinary crystallization. If the process has been carefully watched, — and it is a most interesting and instructive exhibition, — it will be observed that the particles of solid, so soon as they become visible, are rectangular, and that they are polarized. Motion may cause similar poles to approach within the limits of repulsion, when the particle turns and brings its opposite pole in contact, the union taking place at a certain angle, and the frame-work thus laid out becomes closed in by successive layers of polarized particles, forming a regular, solid crystal of a hexagonal form.

The same operation going on in a solution of the same salt, mixed with a solution of common salt, exhibits for some time the same process of construction; but it soon becomes apparent that a *solid prismatic crystal will not form*, and time does not change the condition of the solution. A framework, or *skeleton crystal* is built up as before, and possibly the interstices may be solidly filled, but there will appear a *hexagonal cavity in the centre, representing a considerable part of the volume of the crystal.* If we carefully seal this cavity and remove the crystal, we find the fluid contents to be a strong solution of common salt, and the interior of the crystal has quite finished surfaces. The suggestion at once arises that the crystal, having used in its structure all the saltpetre within reach, has completed its form with a strong solution of common salt. To test the correctness of this supposition, we

may substitute a solid body, choosing one, which, from its fineness can be diffused uniformly, and we shall find that a pure salt will, by its polarizing action on this suspended matter, *fill its cavity quite closely*, and make up its true solid crystal in part of clay, Prussian blue, or other bodies. Ranging through the ordinary salts, cooling from solutions, or the melted state, macle crystals will be obtained almost constantly, while in all cases of slow evaporation and avoidance of those conditions favoring the production of macles, solid transparent crystals only form. Employing thus many thousands of pounds, or only a few grains of salt, the operation of this law of *polarization extended to contiguous matter* is seen, and in the experiments alluded to, it was shown that its modified and more complex action gave beautiful results. Skeleton crystals, such as sublimates, and snow-flakes, and frost-work may be assumed to be *solid crystals*, at the instant of their formation: the vapor, or air, being polarized to fill the vacancies, which afterwards appear, gives the beauty and variety so strikingly presented by them.

Mr. Stodder called attention to forms of clay concretion or segregation, which he saw some years since in Windsor, Ct.

On the bank of the Farmington River, was a bold, nearly perpendicular bluff of the Connecticut valley clay, stratified in horizontal layers of from half an inch to an inch, and perhaps two inches in thickness. The divisional planes between the strata were indurated, perhaps one sixteenth of an inch thick, and somewhat harder than the mass of the clay. Exposed to the elements the softer clay had been washed out between the hardened divisional planes, to the depth of one or two inches. Extending from one hardened plane to another, were cylindrical concretions of from one fourth to three fourths of an inch in diameter, at various distances apart. The bluff, seen in front, presented the appearance of small shelves supported by innumerable small columns, many of which had a small hole through the centre. They looked as if they might have collected about the rootlets of plants, but it is questionable whether roots would penetrate clay to the depth of ten or fifteen feet, or their direction would always be vertical.

The columns undoubtedly were not lime and clay like the clay-stones, but merely indurated clay, as none of them could be found at the base of the bluff, the fallen ones having decomposed.

ON THE REACTIONS OF THE ALKALINE SILICATES.

T. S. Hunt, Esq., of the Canadian Geological Survey, communicates the following memoranda to Professor Dana of Silliman's Journal. He says: — I have lately been engaged in studying the reactions of the alkaline silicates with the carbonates of magnesia and iron. We have long known that carbonate of lime and alumina have the power to remove silicate from a solution of soluble glass; and I find that when a mixture of silica and carbonate of magnesia is boiled with carbonate of soda, the silicate of soda at first formed is decomposed by the magnesian carbonate and the regenerated carbonate of soda is enabled to dissolve a new

portion of silica, the result being a silicatization of the magnesia through the intervention of the alkali.

With soluble silica (as prepared by igniting the silica from the decomposition of an alkaline silicate), this reaction is very rapid, and even when pulverized quartz is boiled for several hours with carbonates of soda and magnesia, a large amount of magnesian silicate is formed. If we substitute proto-carbonate of iron and boil it with soluble silica and carbonate of soda, there is formed a hydrous silicate of the protoxyd permanent in the air.

It will be apparent that by virtue of the power of earthy carbonates to decompose an alkaline silicate, and that of the regenerated carbonate of soda to dissolve silica even in the form of quartz, a small amount of alkali may effect the combination of a great quantity of silica with earthy bases.

Suppose a solution of alkaline silicate, which will never be wanting among sediments where felspar exists, to be diffused through a mixture of siliceous matter and earthy carbonate, and we have with a temperature of 212° F. and perhaps less, all the conditions necessary for the conversion of the sedimentary mass into pyroxenite, diallage, serpentine, talc, rhodonite, all of which constitute beds in our metamorphic strata. Add to the above the presence of aluminous matter and you have the elements of chlorite, garnet and epidote. We have here the explanation of the metamorphism of the Silurian strata of the Green Mountain range, and I believe of rock metamorphism in general.

OBSERVATIONS ON THE SOLUBILITY OF SALTS.

At the Dublin meeting of the British Association, Professor Sullivan read a paper "On the Solubility of Salts at a Temperature above 100 degrees Centigrade, and on the Action of Saline Solution upon Silicates under the Influence of Heat and Pressure." The chief point referred to was the fact, as already observed by Cousé, that sulphate of lime is almost totally insoluble in water at a temperature of 150 degrees Cent. At temperatures above 100 degrees Cent., the salt separating is not the ordinary salt with two equivalents of hydrated water, but the one with the two equivalents of sulphate of lime and one of water. At a temperature of 160 to 170 degrees Cent., the sulphate of lime is deposited in the anhydrous condition — a fact of considerable importance in a geological point of view, as showing that anhidrate may be formed even in water at temperature, which may be readily obtainable in deep seas. He also found Labrador felspar exposed in a solution of common salt to a temperature of 150 to 200 degrees for a considerable time is decomposed to some extent, chloride of calcium being found in the solution.

VON FUCHS, ON THE FORMATION OF THE PRIMITIVE ROCKS.

A biographical sketch of the life of Von Fuchs in Silliman's Journal, thus notices the views of this eminent chemist, in regard to the formation of the

so-called igneous rocks, — views published originally in 1837, but not heretofore generally accessible to the American public. Fuchs opposed the Plutonist and the theory of upheavals, without, however, accepting literally doctrines of the Neptunists. He reasoned against the view that the crystalline rocks were once in a state of fusion, as follows: using granite as the illustration. If granite were once in a molten condition, then as it cooled, in the first place, quartz must have crystallized out, and would have sunk down through the still molten mass, while felspar and mica must have crystallized at a much later stage of the cooling, as the necessary result of their different degrees of fusibility. Further, the inclusion of arsenical pyrites, sulphide of antimony, tourmaline, garnet fluor-spar, &c. by quartz, is incompatible with the crystallization of the latter from a state of fusion. Accordingly the doctrine of upheavals cannot be sustained. In enunciating his own views, Fuchs begins with the proposition, that amorphism must precede crystallization, and assumes that originally, the solid part of the earth consisted of silica and silicates in the amorphous form, while the liquid portions were largely made up of solutions of lime and magnesia or their carbonates, in the then existing excess of carbonic acid. "This I conceive to have been the primal, or chaotic condition of our globe; this may indeed have been preceded by another condition, but to this state it must have come before the formation of rocks could begin."

The formation of rocks, according to Fuchs, began with the silicates. The stupendous crystallization thus induced must have developed light and heat. The latter must have acquired great intensity, — even that of ignition. The products were different as determined by circumstances, namely: granite, syenite, porphyry, mica slate, &c., which in fact, as is known, pass into each other, and may be included together under the term granitic rocks. Also at a later period members of the silicious group were formed, but not so perfectly as at first; examples are clay-slate, and many sand-stones. The lime-stones and calciferous rocks began to be formed simultaneously with the silicious rocks, and the production of both ran parallel through all epochs, down to the most recent times. After the deposition of carbonate of lime, the vast quantities of carbonic acid which had served to hold it in solution, became the material which should especially contribute to the sustenance of organic nature. Says Fuchs, "this acid had from the beginning of the creation a three-fold office; firstly to keep the carbonate of lime separated from the silicates, and for a certain time to retain it in solution; secondly to furnish the atmosphere with oxygen, and thirdly to supply carbon for the production of fossil coal and organic bodies. In recent geological times have probably been formed by their decomposition, two kinds of products, namely: bituminous, containing much hydrogen, and humus-like, containing both hydrogen and oxygen."

Fuchs notices here the objection, that there is not now enough free oxygen in the atmosphere to form carbonic acid with all the carbon of the globe. Accordingly a part of the oxygen originally present must have been devoted to other purposes, and he assumes that it was mostly con-

sumed at a later period in the formation of gypsum. He supposes that before gypsum was formed, there existed the easily soluble hyposulphite of lime, and that it passed into gypsum by oxydation. For such a phenomenon Fuchs offers two explanations, both of which accord with chemical principles, and one of which at the same time, accounts for the presence of free sulphur in the gypsum beds. Either the hyposulphite of lime might be converted into gypsum by immediate oxydation, and the free sulphuric acid thereby formed also yield gypsum, by contact with neighboring carbonate of lime; or the hyposulphite of lime might be resolved into sulphur and sulphite of lime, and the latter pass into gypsum by absorption of oxygen.

Instead of the theory of upheaval, Fuchs proposes a theory of collapse, since by the crystallization of the amorphous masses they would assume a smaller space, and thereby cavities and breaches must be formed, which would result in dislocations, and the falling down of large bodies of rock. The half solid mass which was not crystallized might then penetrate the rifts of the neighboring rock, thus giving origin to veins and dykes. In these revolutions however Fuchs also admits certain upheavals.

The views of Fuchs have found many objectors. Among others Berzelius controverted them and sought to weaken his chief argument against the assumption that the earth was originally in a state of fusion, namely, that in such case all lime must exist now as silicate and none as carbonate, because at a high temperature silica expels carbonic acid from its combinations, by asserting that the density of the vast quantity of aqueous vapor in the atmosphere at that time would have been sufficient to balance the tension of carbonic acid, so that it could remain in combination with lime even in presence of silica. To this Fuchs replied, that at the fusing point of silica, a temperature far higher than that of melted platinum, the tension of carbonic acid must be so exalted that the pressure of the atmosphere could not have prevented its escape, especially since the tendency of silica to combine with lime must have facilitated this separation.

OBSERVATIONS ON ROCK-SALT.

We know that when we melt salt it crystallizes on cooling in different forms, generally in cubes; these crystals are more or less confused, opaque, and always colored; when common salt or crude rock salt is used, the results are different; if salt sensibly pure is calcined and maintained in a tranquil state of fusion, and cooled gently, it forms crystals sometimes of a considerable size, and perfectly transparent.

Out of the air we can melt rock-salt such as is found in nature, without decolorizing it, that is to say, showing different tints of a grayish, red, or brown color; but if the calcination is made in the air, and, as in the preceding case, the fusion is tranquil and the cooling slow, the salt is completely decolorized, the earthy matters are deposited at the bottom of the crucible, the chloride of magnesium decomposes itself spontaneously, and in contact with the moist atmosphere the coloring matters are destroyed

under the oxidating action of the air, and all the impurities are eliminated by the crystallization which has taken place in the mass; there are formed in this manner two very distinct layers, which it is easy to separate.

This operation could perhaps be applied with advantage in purifying crude rock salt, as well as ordinary sea salt.

The fusion of the salt in contact with the air, or out of the air, will explain, to a certain extent, how it is that the salt found in the bosom of the earth is generally contaminated with coloring matter, and how, on the contrary, that which is exposed to the oxidating action of the atmosphere is white and transparent.

From these facts we cannot determine as to the origin of the formation of rock salt, for, by fusion, we can obtain salt having a transparent appearance, with physical properties defined; but the presence of organic remains enveloped in the natural product excludes the probability of its being formed by igneous fusion; besides, it is difficult to imagine, if the mass had really been in a state of fusion, why it was that the chloride of magnesium was not decomposed. As to the phenomena of decrepitation which has been observed to a certain extent in rock salt, the same has been noticed in salt crystallized in the wet way, therefore this cannot confirm the hypothesis of igneous formation.

Without pretending to decide the question of origin, these experiments show a product analogous, if not identical, with natural rock salt — *M. Margueritte, Comptes Rendus.*

NEW AND CURIOUS GUANO PRODUCT.

At a recent meeting of the Boston Society of Natural History, Dr. A. A. Hayes exhibited some specimens, resembling Trachyte rock so closely, that most observers would have mistaken them for Trachyte.

The specimens consisted of hand specimens, having the uneven fracture of trachyte, full of capillary passages, with some cavities; there were fractured planes of brown and flesh-colored minerals, resembling felspar, and some small red, brown-colored and black granules; but the most characteristic mark was the occurrence of angular fragments and grains of yellowish green color, hardly distinguishable from *epidote* by the eye. The external surface was brown and uneven, like that of a weathered basalt, or trap. The island from which these specimens came has been examined by a geologist, and from the prevalence of this rock, it is said that he pronounced the island to be of volcanic origin. A mass was sent to Dr. Hayes, and he found it had structural planes, the divisions producing trapezoidal masses, their surfaces and the lines marked by darker colors, and, so far as could be determined, there was evidence of the mass being part of a rock formation of some extent.

The chemical composition discloses the remarkable fact that this rock is composed essentially of fish bones and altered shells, which have passed through the alimentary canals of sea fowls. Referring to communications before made,* Dr. Hayes stated that the organic matter of fish bones in the

* See Annual of Scientific Discovery for 1857, pp. 242, 243, 244.

droppings of fowl, reacts on the bone phosphate of lime, to eliminate acid salts of phosphoric acid, and these cement other portions, or decompose shells, which are composed of carbonate of lime and animal tissues. The felspar-like granules are generally compact, colored portions of converted shells, having a crystalline form, and there are aggregates of ferruginous and aluminous phosphates, arising from the same kind of action on ferruginous matter, which, in the form of a fine clay, or volcanic ash, has been brought within the sphere of the action of the acid phosphates. The cavities sometimes present minute crystalline facets of phosphate of lime crystals, while the capillary channels and pores, which give the trachyte-like character, are really the passages through which the carbonic acid and other gases escaped, during the transformation of the organic matter, precisely as they occur in basalt and trap, where igneous action has been supposed to have been influential.

This rock is covered more or less by Atlantic guano rock, presenting the variety which consists of compact, light-colored phosphate of lime, containing about twenty parts in one hundred of carbonate of lime, and in some parts is a consolidated shell-bank; the recent shells and coral fragments being visible. Where, through time and favorable exposure, the bone remains have thoroughly decomposed the shells, hand specimens would be mistaken for the flesh-colored, massive phosphate of lime of New Jersey. These more or less well-cemented and altered rocks are also connected with still more recent deposits, retaining even the odorous animal remains of oily acids; and the whole formation, above that of the trachytic form of rock, contains the remains of infusoria.

Thus a small island of the Atlantic, lying about eighteen degrees north of the equator, presents us with an epitomized succession of rock strata, formed from materials which, once endowed with life, have served to nourish other living systems, and then given rise to chemical changes, resulting in the production of various mineral solids which remain.

The trachyte-like rock forming the basis rock of this island, theoretically, may have received its geological and chemical characters in ocean water. A subsidence of the land, after its surface had been deeply covered with organic remains, would allow of that aqueous action of decomposition and cementation which we notice, and the subsequent desiccation would explain the natural divisions by rents. The formation of silicates of iron, manganese, and allumina from phosphates of lime, is a mineralizing process which can take place in ocean water by infiltration, volcanic ashes, or divided materials of plastic rocks being present, as analysis shows them to be. The rock is hydrous, losing nearly ten per cent. of its weight by ignition, or

Water with a little organic matter,	10.00
Bone Phosphate of Lime,	85.20
Carbonate of Lime,	3.00
Oxides Iron, Manganese and Alumina,	5.22
Silicic Acid and Sand,	1.78
	105.20

The excess of weight being due to the estimation of the phosphoric acid united to lime as bone phosphate of lime, while truly part of it, with a portion of silica, is united to the oxides present.

These facts prove that mineral masses containing phosphate of lime, may be thus formed from animal phosphate of lime, and present all the characters which we recognize in the phosphate of lime contained in the oldest slates. Additional interest has been given to this subject, by the investigations of Prof. Booth of Philadelphia, and Dr. Piggott of Baltimore, who have analyzed specimens, in which the phosphoric acid had combined with both oxide of iron and alumina.

ON THE SOLUBILITY OF BONES IN WATER.

BY PROFESSOR WÖHLER.

When bone-dust, such as is commonly employed as manure, is left for some time in contact with water, and the latter is filtered away, it is found to contain appreciable quantities of the phosphates of lime and magnesia. The same result is obtained when the water is freed from carbonic acid by long boiling. By filtering water for months through the same mass of bone-dust, it was found constantly to contain these earthy phosphates, and their quantity even appeared to increase in proportion as the organic matter of the bones became putrid in consequence of its long contact with water and air, and the water flowing off became turbid and offensive. This fact seems to have some practical value in agriculture, as it shows that without any artificial preparation the earthy phosphates may be extracted from the bones and introduced into the soil in a state of solution, perhaps exactly in the quantity necessary for their appointed functions, and that in the employment of bone-dust as manure, all the preparation necessary is perhaps to lay it in heaps during the summer, and keep it constantly moist. — *Liebig's Annalen.*

ON SILICIFICATION AND THE CEMENTING MATERIAL OF CONGLOMERATES.

In the course of a recent discussion before the Boston Society of Natural History, Dr. Hayes stated that he had made a somewhat extended examination of the cementing material of the well-known Roxbury conglomerate, and found that it was for the most part silicate of lime. There are cases where finely-divided slate argilite forms, with silicate of lime, quite large quantities of cement, uniting pebbles of considerable size ; but these exhibitions are only another feature, referable to the action of the same silicious compound. The Roxbury conglomerate contains chlorine, and as chloride of calcium is readily decomposed by hydrous silica, it might be assumed that the silicate of lime was thus formed. But the conglomerate is very frequently traversed by bold dykes of trap, which contain a large amount of sulphuret of iron, and the fissures in the conglomerate, being often filled with sublimed quartz, the more probable supposition is, that silicate of lime was formed by the transportation of silica in the heated vapor of water. Such silica would combine with the lime and alumina of the comminuted

slates, and form the cement at the points where we now find it. Dr. Hayes also expressed, as his conclusions respecting the silification and consequent preservation of organisms, — that the process proceeded, step by step, with the change of the organism into gaseous or aqueous matter. The mollusca may be considered as simply *organized water,* for one hundred parts by weight, often contain ninety-seven parts of water, volatile at 150° F. The cell walls of albumino-gelatinous matter are permeable, and the infiltration of aqueous solutions of silicate of lime, would displace the water, gradually depositing silica in a hydrous state, while the lime passed out with the water. As consolidation is hastened by the decomposition of the animal matter, the cell walls become changed, and the carbon or humus, in excess over that which can become gaseous or aqueous, remains; retaining as a mere skeleton the forms of the walls. These silicified forms are always porous, and the flints contain the carbon of the organic matter, unevenly distributed. As a beautiful illustration of silification, he referred to the specimens of trees from California, frequently found in the explorations for gold; many of the specimens presenting the sap vessels entire in all their delicate organization and nearly natural color, while near by, on the same piece, may be seen black portions, in which the organized forms are lost, and the color is deep black. This striking diversity is due to the fact that the wood at some points had passed into the last stage of humus, — carbon and water, — before silification took place, and hence the specimens present us with both silicified wood and silicified charcoal. He observed the same changes, though less obvious, while examining the highly interesting locality on the Island of Antigua.

Dr. C. T. Jackson remarked that he had examined the materials which enter into composition and cementation of sand-stones and conglomerates, and had found the cements to be different in different cases. In some, carbonate of lime forms the principal cement, in others, oxide of iron composed a large proportion of the cementing matters, and in others, finer particles of the same rocks that composed the conglomerate had formed a patse, which had been hardened by the agency of heat and by the production of silicate of lime derived, undoubtedly, from the decomposition of chloride of calcium. He stated that when pebbles are moistened with a solution of chloride of calcium, and then placed in contact and heated, the chlorine of the chloride of calcium escapes, and the oxide of calcium or lime unites with the silex and forms silicate of lime. There could be no doubt that the chloride of calcium was derived from sea-water. Sometimes in the vicinity of trap dykes, as at Purgatory, near Newport, Rhode Island, specular iron ore, evidently derived from sublimation of oxide of iron from the chloride of iron, had invested the pebbles with a thin crystalline film, which served as a cement.

The cementing materials of some sandstones are so largely calcareous, that on removal of the carbonate of lime by the action of acids, the stone crumbles into sand. In such sandstones the carbonate of lime was probably infiltrated as a bi-carbonate, and on losing one equivalent of carbonic acid, the carbonate of lime would solidify in crystalline form and firmly unite the sand, making it into a solid rock.

If a sandstone, cemented by carbonate of lime, is exposed to a high temperature, silicate of lime would be produced by combination of silex with the lime, and carbonic acid gas would be disengaged.

ON THE GASEOUS PRODUCTS OF VOLCANOES.

The following investigations of the gaseous products of the volcanic mountains of Italy, were made by M. Deville, in common with Leblanc and Sewy: — 1. Gas which was collected in May, June, September and October 1855, at various points of the stream of lava from the eruption of Vesuvius, on May 1, 1855. The analyses of this gas showed that the gas which issues from those fumaroles which have been called dry fumaroles, and which only carries with it anhydrous alkaline chlorides and small quantities of sulphates, is nothing but a stream of air either unaltered or containing less oxygen, thus—20·1 and 20·6 per cent of oxygen were found in it. The same is the case with the gas loaded with vapors of muriate of ammonia, which was expelled from the lower parts of the lava in October. — 2. Gas collected in September from the fumaroles on the small plain in the centre of the upper crater of Vesuvius. This gave aqueous vapor of the temperature of 140 deg. to 174 deg. F., mixed with a little vapor of sulphur and sulphuretted hydrogen. In one sample of this gas 3·51, in another 9·26 per cent. of carbonic acid were found. The remainder was only air, from which nearly all oxygen was extracted. — 3. Gas collected in September and October, from those fumaroles on the summits of Vesuvius and Etna which throw up a mixture of aqueous vapor, muriatic acid, and sulphurous acid, at high temperatures, 194 deg., 257 deg., and 356 deg. F. This again is nothing but air partially deprived of oxygen. — 4. Gas collected in September 1855, on the upper border of the cone of eruption of Etna (1852). This upper margin, in June, still possessed an abundance of fumaroles of sulphuretted hydrogen of 182 deg. F. In September, they only emitted aqueous vapor of 142 deg. F.; which was perfectly neutral, and the vapor was only accompanied by air. The constitution of these gases, which escape from the summits of Vesuvius and Etna, is such as we might have expected. Air is always intermixed with the gases; and the emanations of carbonic acid, sulphur, sulphuretted hydrogen, muriatic acid, and sulphurous acid, are products such as the cleft crater must furnish in the same way as a cracked chimney over a fire. — 5. Gas collected on the 5th and 22d of October, in the Lago di Naftia or Lac di Palici in Sicily. The composition of this gas varies with time. In none of the gases could a combustible gas be detected. — With reference to the solid productions of the eruption of 1855: two kinds of lava flowed out in this eruption. The one which made its appearance last is dark, as it were furnished with a glassy coating, and has no action upon the magnet; while the other kind is gray, much more crystalline, and strongly magnetic. Both contain nearly the same amount of iron, so that the iron is not contained in the same form in the lavas. The one contains 1·4, the other 2·2 per cent. of phosphoric acid. Both contain some chlorine, a portion of which is as it were mixed in the form of a soluble chloride, whilst another portion is not washed out with water, but only obtained by the decomposition of the mine-

ral with bisulphate of potash. Phosphoric acid is always present, and so also is chlorine, which constitutes about 3-1000ths of the lava examined. Chlorine is also found in the rocks of Puraci, in an amphigenous stratum of the Somma, and in a slag-like stratum of the same mountain. The felspar of the lavas of Vesuvius appears to be amphigenous, and is distinguished from that of the Somma by its only containing traces of soda; while in the felspar of the lava of 1855, the oxygen of the soda is in the proportion to that of the potash as 2·09 : 1. This proportion in the mineral of Fasso-grande is 8·21 : 1, and in the amphigenous perfect crystals which were thrown out of the volcano on the 22d of June, 1·67 : 1 according to Damour.

ON THE EMPLOYMENT OF SULPHURET OF CARBON FOR INDUSTRIAL PURPOSES.

In a communication to the French Academy on the above subject, M. Dietz commences by stating, that in 1840 the price of sulphuret of carbon was as high as from fifty to sixty francs the kilogramme; but that soon afterwards he reduced its price so greatly that in 1848 it sold at eight francs the kilogramme for the purpose of vulcanizing India-rubber. At present, with an apparatus composed of three retorts, he is able to manufacture the immense quantity of 500 kilogrammes of sulphuret of carbon in twenty-four hours; although scarcely a year ago, with the same furnace, the same retorts, and the same amount of fuel, he could only produce 150 kilogrms. in the same time. The product now costs him only 50 centimes the kilogramme, and he has no doubt that, by operating on a larger scale, it might soon be sold at 40 francs per 100 kilogrms. As, however, this substance has at present only a very limited employment in the vulcanization of India-rubber, the author having a large quantity on his hands, naturally desired to find some other purpose to which it might be applied; and considers that he has discovered one of the greatest importance, namely, the extraction of fatty matters.

He states that Paris daily produces 30,000 kilogrms. of bones, which are collected by the *chiffoniers* and carried to the manufactories of ivory-black and gelatine. Here they are sorted, some being devoted to the production of ivory-black, others of gelatine, whilst some are sold to the workers in bone. The greater part of them (25,000 kilogrms. daily) are employed in the manufacture of ivory-black; but these undergo a preliminary treatment for the extraction of their fatty matter. The bones are broken and boiled with water, for about three hours, in large caldrons; the fat floats on the surface and is skimmed off; the bones are taken and thrown into a heap, to undergo a kind of fermentation, in which the production of heat induces a state of desiccation which fits the bones for calcination.

In these operations the bone undergoes a great alteration: the long boiling in water dissolves a great portion of the gelatine, which is necessary for the production of a good black; and the fermentation and long exposure to the air causes the almost total destruction of the animal matter, so that a bad black is produced for the sake of only 5 or 6 per cent. of fat.

The author states that much more advantageous results may be obtained by the employment of sulphuret of carbon. He proposes to crush the

bones almost to powder; then to treat them with this agent, which almost instantly dissolves all the grease contained in them; and from this it may be separated by distillation, which is greatly facilitated by the low temperature at which this fluid boils, and the ease with which it may be condensed. The quantity of grease thus obtained is 10 or 12 per cent., and it is superior to that procured by boiling.

He adds, that the same agent may be applied to the extraction of oils from oleaginous seeds and of the grease from wool. In the latter case the grease extracted becomes a useful product; it is a butyraceous substance, adapted for the manufacture of some kinds of soap.

ON SOME NEW METHODS OF TREATING LINSEED OIL.

The following is an abstract of a paper recently read before the Society of Arts, London, by Mr. C. Binks:

Linseed oil appears in four different forms: 1st, the oil in its natural state, called *raw* oil; 2ndly, this raw oil *refined*, or from which has been separated its mucilage and coloring matter; 3rdly, the raw oil *boiled*, that is, made or intended to be made more drying than the original oil; and 4thly, the raw oil put into a variety of conditions as to thickness, color, etc. The strongest oil used by the artist's color-maker the writer found to consist chemically of a solution, in any excess of oil, of the oleate of lead, which had obviously been made by heating raw oil along with litharge and water, and afterwards expelling, by heat, the *excess* of water used. This kind dried, *per se*, in fifteen hours.

The *refined* oil, in paint-making, is employed chiefly as the vehicle in which to grind white pigments. The raw oil is used to thin and prepare for use the finer kinds of paints, from which *boiled* oil is excluded by its dark color and after-effects. The raw oil is, of itself, a very slow drier. The refined is still more imperfect in this respect; and hence, to quicken the work of the operative painter, arises the necessity for using, along with these two, spirits of turpentine or the compositions called driers.

The clear oil produced after boiling, even when from the very best makers, always contains a considerable quantity of lead, and is dark-colored — almost black, and does not, on exposure to air, materially bleach. Its rate of drying, *per se*, is, on an average of the best kinds, fifteen hours; but more generally ranges between twenty-four hours and sixty hours.

The oil-boiling trade is divided chiefly between two classes: — the paint manufacturers and grinders, who boil oil for their own use and for their own sale; and the oil boilers and refiners, who receive from the oil merchants and from consumers — not themselves boilers — the raw oil, put it through the operation, and return it at a certain charge per ton.

The problem is to take the raw oil and give it an efficient rate of drying property, that can be modified at pleasure; to give to it any color, ranging between dark brown and straw color; and to give to it any required degree of limpidity or viscidity that will fit the multifarious requirements of the manufacturer and artist.

To test the drying rate of an oil, or of an oil mixed with some material to dry it, it is simply necessary to spread it upon the surface of glass, and expose it to the atmosphere, and to note the time occupied in its passing from its fluid to a solid state; and the circumstance that on its being touched with the finger, and neither adhering to it on removal, nor resisting its removal, is taken as evidence of its being dry. The drying rate of an oil is materially affected by temperature — the hygrometric condition of the atmosphere, by its state as to stillness or motion, and by the presence or absence of sunlight, etc. An oil that in a warm, breezy summer's day will dry in eight or ten hours, may not dry in less than sixteen or twenty when the air is foggy and motionless; and in an unfavorable winter's day may not dry in less than from twenty-four to thirty hours.

The practical results of a vast number of experiments made by the writer are thus given:

When an oil or an oil paint, on exposure to air, dries, four distinct kinds of action come into play, to effect, or contribute to that result. These are —

Firstly. — The chemical actions taking place naturally between the oil and the atmosphere, or the *natural* chemical action consequent on exposure.

Secondly. — Those due to some specific chemical action upon the oil of some element in the pigment, or the *induced* chemical action, as contra-distinguished from the natural.

Thirdly. — Those due to the peculiar physical *structure* of the composition of the paint, through which, within the same superficial area, a larger surface of the oil is brought under the action of atmospheric agencies.

Fourthly. — Purely *mechanical* actions, brought about by molecular disturbances in the oil or paint, by which fresh particles of the oil or fresh surfaces of it are being, during the time of exposure, continually thrown up to the action of the atmosphere.

In any instance of an oil or a paint drying, the influences at play to contribute to that result can be traced to one or other, but most frequently to the combined effect of two, or of all of those kinds of actions.

The experiments showed that the *hydrated protoxides* of certain metals pre-eminently exercise a specific drying action on the oil. The hydrated protoxides of iron, of nickel, of cobalt, and of manganese, are the most remarkable of the class; but it is through the latter (i. e., the hydrated protoxide of manganese) that all the singular and happy effects upon the oil are to be practically accomplished. The addition to the oil of only from three to five parts of the hydrated protoxide of manganese to 1,000 of the oil, gives birth to peculiar changes; and, by the simplest of methods of after treatment, this chemical fact is made applicable to the production of any required kind of drying oil.

Arrangements for manufacturing drying oils on this principle have been adopted, under the writer's direction.

The oil, used in very large quantity at a time, is mixed with hydrated protoxide of manganese, or materials yielding that, in quantity ranging between five pounds and fourteen pounds to the ton, and the oil warmed up to from 100 to 150 deg. Fah. In a very short time — ten or twenty minutes

— the oil loses its peculiar yellow color, passing through a greenish into a brownish tint, whilst the oxide disappears, being dissolved in the oil. In this state of "solution," as it is called, the oil has already had given to it, by this simple, rapid, and inexpensive operation, a very considerable amount of drying power, and is fit in this state, to be applied to a multitude of purposes.

ON A NEW SULPHIDE OF CARBON (CS)

As yet only one sulphide of carbon has been known to exist, namely, CS^2, corresponding to carbonic acid CO^2. A protosulphide CS corresponding to carbonic oxide CO has never been obtained. At a recent meeting of the French Academy, M. Baudriment announced its discovery, and gave the following brief account of its preparation and properties: —

Protosulphide of carbon may be obtained by the following processes:—1st, By decomposing the vapor of ordinary bisulphide of carbon with spongy platinum, or with pumicestone, heated to redness; under these circumstances, the bisulphide is decomposed, an abundant deposit of sulphur takes place, which often chokes up the tube, and a gaseous body is formed, which is the protosulphide of carbon CS. This well defined reaction is sufficiently explicit. 2d, It is obtained simultaneously with the bisulphide when that body is prepared by the ordinary method. 3d, By decomposing the vapor of CS^2 at a red heat with pure lampblack or wood charcoal, but especially with fragments of animal charcoal. 4th, By decomposing the vapor of the bisulphide with hydrogen at a red heat. 5th, By calcining sulphide of antimony with an excess of charcoal. 6th, By the reaction of carbonic oxide upon sulphuretted hydrogen at a red heat.

$$CO+HS=HO+CS.$$

The first process yields the gas in a state of purity; but when obtained by the other methods, it is contaminated with sulphide of hydrogen or carbonic oxide. It may, however, be purified from those by being rapidly passed through a solution of acetate of lead, chloride of copper dissolved in hydrochloric acid, and then drying the gas collected over mercury.

This body is gaseous, colorless, and possesses on odor, reminding one of ordinary sulphide of carbon, but not disagreeable, and strongly ethereal. Respired in any large quantity, it appears to be powerfully anæsthetic. It burns with a bright blue flame, producing carbonic acid and sulphurous acid, with a little sulphur. Its density is a little greater than carbonic acid. It resists the cold-produced mixture of ice and salt. Water dissolves about its own volume of it, but the solution rapidly decomposes into sulphuretted hydrogen and carbonic oxide. It is not more soluble in alcohol or ether.

At a red heat it is feebly decomposed — 1st, by a spongy platinum; 2d, by the vapor of water into HS and CO; 3d, very readily by hydrogen into HS and CH; 4th, by copper into graphitoid carbon and sulphide of copper; and, finally, by exposure to the sun with an equal volume of chlorine, a reaction takes place, a partial condensation and formation of compounds,

which I am at present investigating. Analyzed by oxygen in the endiometer, it gives equal volumes of carbonic acid and sulphurous acid, from which we may deduce the formula CS as representing its composition.

Many chemists have attempted to discover this body; and its having escaped their investigation, is attributable, without doubt, to its reaction upon water and the solutions of the alkalies, which resolve it into carbonic oxide and sulphuretted hydrogen. — *Comptes Rendus.*

ON THE CHEMISTRY OF WINES.

Mulder, the celebrated German chemist, has published during the past year an interesting contribution to popular science, entitled the "Chemistry of Wine." Referring to the little progress which has yet been made in the accurate analysis of the various kinds of wine, he says: — The almost unlimited variety which is peculiar to wine, and depends entirely upon variations in the constituents of the wine, has never been traced back to its cause; and further, many methods of determining even the most ordinary vinous ingredients are still imperfect, and must be replaced by others. Lastly, there are many adulterations practised upon wine, which keep pace with the extension of chemical knowledge, and which have been as yet by no means sufficiently explained. We have only to consider the immense multitude of wines, all differing in color, odor, flavor, to be satisfied that an exact chemical knowledge of them must be almost impossible. The composition differs according as the wine is red, or not red. In the last mentioned, no particular coloring matters are found, and only a trace of tannic acid; in the former both are present. Alcohol and water are also among the principal ingredients, then sugar, gum, extractive and albuminous matters; then free acids, such as tartaric, racemic, malic, and acetic acid, tartrate of potash, of lime, and of magnesia, sulphate of potash, common salt, and traces of phosphate of lime; also, and especially in cellared wines, substances which impart aroma, as œnanthic and acetic ether, in variable proportions, and other volatile matters. In red wines and in many others, a little iron, and, according to one statement, some alumina, may also be detected. Lastly, the best wines contain, according to Fauré, a peculiar substance, which he calls œnanthine. These ingredients vary exceedingly in proportion. The quantity of some is so insignificant, that the substance almost disappears during analysis. The quantity of some may be determined by weight, and of others again is still greater. Most of the properties of wine depend upon the sugar, alcohol, tartaric acid, and water, which exist together in it; that is, putting aside taste and smell as standards of comparison. By a comparatively rough analysis the proportions of the chief ingredients may be ascertained, but no chemistry can detect the formation or exhibit the existence of the aroma which gives to some wines their fabulous value. Science can investigate the organic constituents and point out the relation between the ingredients of the soil and the vegetable structure, but science is unable to bring the structure of plants into connection with the nature of their special products.

It is not strange that the grapes which grow on the sunny side of the Johannisberg should be very superior, as far as the flavor and fragrance of their juice is concerned, to those produced on the opposite side of the mountain; nor that, in general, a hotter and stronger wine is produced in warm regions than in such as are cold or temperate. If we add to this, that the peculiar nature of the soil, its constituents, the influx and drainage of water, the lightness or stiffness of the ground in which the roots spread; that, further, the dryness or dampness of the air, and the change or equality of temperature, exercise a well known influence upon plants and the fruits produced by them, we shall at least have a general idea of the varieties of the juice which constitute the principal element of these berry-bearing fruits.

It is, moreover, sufficiently known that there is a general difference in the color of grapes, between black, purple or red, and white; the juice of both is colorless, and colorless wine can therefore be obtained from both. If the black, purple, or red grapes are pressed, and the skins thrown aside, a colorless wine, which in substance equals that procured from the juice of the white grape, is obtained by fermentation. I say substantially, for the variety in the juices, which even a slight difference in the external influences occasions, would effectually prevent the one fermented liquid from equalling the other in flavor and aroma. Or is it, perhaps, that the heat of the sun penetrates more thoroughly the purple grape, while its dark skin partially preserves it from the action of light?

Is then, the same chemical action possible to the juice of the purple grape (inclosed, as it were, in a small bladder) as that which is produced in the juice of the white grape by the difference between these two powerful influences, heat and light? We know that in our regions the white grapes are much sweeter than the purple, and ascribe this peculiarity to the difference of the plants, but forget that in the easier passage of the light through the colorless skin of the white grape we possess a sufficient explanation of a more powerful chemical action, the result of which may be a larger formation of sugar. And if we generally find the purple grapes inferior in flavor and smell, we must ascribe this circumstance to heat, which in this case penetrates more easily the skin of the grape, and which in all living things is a powerful means of exciting chemical action.

The opinion that wine which has grown old in bottles has therefore become richer in alcohol, is thoroughly false. I do not deny that the alcoholic contents of many old wines is considerable, but I deny that the wine being kept in bottles increases it. Evaporation is very much hindered by the cork, even when it is not covered with resin and sealing wax. The sugar which exists, for example, in red wine, is in too insignificant a quantity to evolve alcohol by means of fermentation; and in old wine, the opening of the bottle causes no escape of carbonic acid. Therefore, the formation of alcohol in the bottles is impossible. The simple explanation of our finding old wine rich in alcohol is, that only the stronger wines can be preserved, and the weaker ones cannot resist the effects of time. The color of wine is materially affected by another change which it undergoes when cellared (I am sup-

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posing it to be in bottles). The color of liqueur-wines becomes darker, but such wines as are rich in tannic acid, port, for example, deposit a sediment, and become lighter. Red-wines, which contain no large amount of tannic acid, generally grow darker. The details, which must be mentioned, in order to explain this change, will be better understood when we come to consider more particularly the coloring matter of wine. With regard to the fact just mentioned, that wines which are not rich in tannic acid, acquire a darker color, I will only observe that the diminution of free acid in the wine (be it tartaric or acetic) is always connected with this appearance, for the red hue is the effect of free acid, and the decrease of such acid allows the coloring matter to appear more purple.

Corking is an operation that may seriously affect the chemistry of wine, and the mischief resulting from the growth of mould, causing a musty flavor, is so frequent, that the professor expresses surprise that other contrivances are not adopted for excluding the air.

"It really seems strange that in this age, when so many other means can be employed, cork should still be made use of to stop bottles. The moist cork, one side of which is in contact with the air, allows, equally with the wood of the wine-cask, the development of mould plants. The taste and smell of wine is, under such circumstances, identical with that of many other mouldy substances, and is what we call musty. The mould of cork differs of course from that of wood, and the taste is consequently not exactly the same. The smell may be distinctly perceived in almost every warehouse in the country. The mould grows from the outside to the inside, and should it reach the inner side of the cask or cork it imparts a taste to the wine. On this account old wine casks must from time to time be cleansed outside and inside, and new corks must be put into the bottles, even when the old ones are unhurt. If the inside of the cork be covered with resin or sealing-wax, the entrance of the air is cut off, and the formation of mould hindered, though not prevented. Wines which have been long in bottle often acquire an unpleasant taste from this mouldiness; they are brought out to do honor to a guest, and praise is expected, which cannot honestly be given."

IMPROVEMENTS IN THE MANUFACTURE AND PREPARATION OF FAT, OILS, ETC.

Production of Stearine and Oleine. — A patent has been recently granted in England to Mr. Hills, for improvements in the production of Stearine and Oleine. His method consists in mixing the fat, heated to 110° Fah., with ten per cent. dry sulphate of lime, chloride of calcium, or other suitable substance capable of absorbing water; then adding five per cent. hydrochloric or nitric acid, and stirring the whole together for an hour; water is then added, and heated, by means of steam, to the boiling point, until the acid is entirely separated from the fat, when it is run off and melted to separate water, and pressed to separate oleine. A stream of hydrochloric acid gas or nitric acid vapor may be used instead of the liquid acids and sulphate of lime or chloride of calcium.

Castor Oil. — M. Berris, a French chemist, has recently pointed out several new uses for castor oil, which will undoubtedly increase its commercial value. He says:

"By distilling castor oil upon concentrated potash, the sebacic acid and caprylic alcohol are extracted as separate products, which may be turned to good account. The sebacic acid, having a high melting point, may be employed, instead of stearic acid, in the manufacture of candles, and if it be mixed with stearic acid, the hardness and quality of the candles are greatly improved, and in appearance they resemble porcelain. It is possible to use caprylic alcohol in all the purposes to which ordinary alcohol is put, particularly in illumination, and in the composition of varnishes, and from it certain other compounds may be derived, of remarkable odor, similar to those which are at present largely used in commerce."

The cultivation of the Palma-Christa plant, which produces the seeds from which castor oil is pressed, has been somewhat extensive in this country, particularly in Illinois; but owing to the limited use of castor oil, the demand has not been large enough to warrant extensive planting. But its application to other purposes may increase the demand and make its cultivation profitable; as it would be at one dollar a bushel for the seeds, in many places south of latitude 40°, up to which point the plant matures without much danger of frost, and although it grows much larger further south, it does not afford as great a yield in Mississippi as it does nearer the northern limit of its growth.

Nuisances arising from Tallow and Soap-works. — The question whether it is practicable to prevent the obnoxious smell produced in the melting of tallow and in soap-boiling, has recently been examined specially by Hrn. Grodhaus and Fink, in consequence of complaints that have been urged against the proprietors of candle and soap-works in Hesse Darmstadt. Professor Stein, Dresden, has made experiments on this subject, and recommended the tallow to be covered with a layer of charcoal while melting. This plan was tried, but without satisfactory results. Hrn. Grodhaus and Fink recommend passing the vapor into the furnace a few inches above the bars, so that it may be burnt and carried away by the draught of the chimney; or passing it else into the chimney itself. For this purpose the melting vessel is to be covered with a closely-fitting wooden lid, furnished with a tube, passing either into the furnace or the chimney. By this means it was found that, with arrangements of apparatus, otherwise similar to what are generally employed in candle and soap-works, the offensive smell could be prevented, whether the fat was melted dry over the open fire, or by the aid of high pressure steam. An attempt was made to pass the vapor, when melting by steam, through the fire, but it was found to put out the fire, although this was not the case when the vapor was passed into the furnace over the burning fuel.

ARTIFICIAL PRODUCTION OF GLYCERINE.

Wurtz has succeeded in preparing glycerine artifically from the tribromid of allyl, $C^6H^5Br^3$, which is obtained by the action of bromine upon the iodide

of allyl, C^6H^5I, iodine being set free. The bromid is a heavy colorless liquid which, at a temperature below ten degrees centigrade, crystallizes in beautiful colorless prisms. By the action of this bromid dissolved in acetic acid upon acetate of silver an oily liquid was obtained, boiling at 268° centigrade, neutral, colorless, and heavier than water. This liquid is triacetine, $C^{18}H^{14}O^{12}$. By saponification with baryta-water, acetate of baryta and glycerine were formed. The latter was identified by its properties and by analysis. — *Comptes Rendus*, xliv. 780.

SOLVENT PROPERTIES OF GLYCERINE.

Advantage is being taken of the solvent and preservative properties of glycerine, in the preparation of medicines, both for internal and external use, and of various essences for culinary purposes. Glycerine approaches very nearly to diluted alcohol in its solvent power. It is supposed to possess the same power of supporting nutrition as cod-liver oil, and to be more easily digested in many cases. This, however, requires the confirmation of experience. Many specimens have been sent us of medicines prepared with it, such as iodide of iron, quinia, iodide of quinia, carbonate of iron, iodine, tannin, perphosphate of iron, etc. The culinary preparations are essence of cloves, essence of cinnamon, lemon juice, lemon flavoring, etc. The flavor is well preserved. It is extremely probable that in many cases glycerine will supersede alcohol as a solvent and preservative. — *Med. Times and Gaz.*

A correspondent of the London Society of Arts, in Guatemala, also recommends glycerine as an invaluable remedy for insect bites.

ON THE COMPOSITION OF DISINFECTING POWDERS.

At a late meeting of the London Society of Arts, Dr. Smith, of Manchester, communicated the results of some important researches made by himself and Mr. M'Dougall on disinfecting agents. An examination of the various bases was first made. Of these, magnesia was found to be the most valuable as a disinfecting agent, forming an insoluble ammoniacal salt, and one which naturally exists in the economy of vegetation. On a similar comparison of the acids, the sulphurous proved the most efficient; its disinfectant power equalling that of chloride without decomposing the ammonia; a natural constituent of the soil being also the result of its action. A combination of the base and acid in the form of sulphite of magnesia was next tried with signal success, a slight odor, however, still remaining. The known influence of phenic or carbolic acid (one of the products of coal-tar) led them to combine five per cent. of it with the salt previously employed. By this means a disinfecting powder was produced, which has proved remarkably efficient in all instances where it has hitherto been tried; in districts infested with fever, and in cases of far advanced decomposition.

ON THE EMPLOYMENT OF FERROCYANIDE OF POTASSIUM FOR THE REMOVAL OF RUST-SPOTS IN WHITE LINEN.

The employment of ferrocyanide of potassium may often help us out of great difficulties in the case of rust-spots in linen. These do not always consist of common hydrated oxide of iron, but also frequently of oleate of iron, which can only be removed with difficulty, and with the assistance of heat, by oxalic acid, or the binoxalate of potash; and often not at all by sulphuric or muriatic acid, for these acids can only be applied cold and very dilute, as otherwise the linen suffers. From the high price of oxalic acid, therefore, a cheap means is wanting, when a great quantity of such iron moulds is to be destroyed. A case of this kind once occurred to the author, in which sulphate of iron had been used instead of potash, by which three hundred napkins and other table lined all acquired a rusty yellow color, which, on being washed with soap, instead of disappearing, became darker; the sulphate of iron being decomposed by the soap, and oleate of iron precipitated upon the fibres.

Immersion even for several days in water acidulated with sulphuric and muriatic acids produced no effect, because the oleate of iron was not decomposed. It was here that the ferrocyanide of potassium did such excellent service. It was added in comparatively small quantity to the water, acidulated with sulphuric acid, and the linen was then moved about in the fluid. The linen became blue. When all the yellow had disappeared, and a clear blue had made its appearance, the linen was rinsed and treated with solution of carbonate of potash. Here the blue color again disappeared, and with it a great part of the yellow, which only remained in spots. These were then very easily got rid of by dilute sulphuric acid alone.

The explanation of this process is easy. By the formation of Prussian blue, the oleic acid is separated from the oxide of iron. The carbonate of potash then brought into action combines with the oleic acid, decomposes the Prussian blue, and at the same time also dissolves the greater part of the oxide of iron, so that almost all the iron mould disappears from the stuff simultaneously with the Prussian blue. Caustic ley does not act in the same way; it certainly destroys the blue, but the rusty yellow remains, because it has not the same solvent action upon oxide of iron as carbonate of potash. —*Prof. Runge, Polyt. Centralbl.* 1857, p. 542.

ON THE APPLICATION OF ANÆSTHETICS.

At a recent meeting of the French Academy M. Heurteloup read a paper on the application of anæsthetics. When ether or chloroform is administered by means of a sponge held at a short distance from the nostrils there is no ascertaining the quantity inhaled, since the breath of the patient or the slightest draught may cause the vapor to deviate. Moreover, in spreading and mixing with the ambient air it may cause convulsive coughs and other inconveniences; and sometimes, after long and fruitless efforts to produce stupefaction, this effect is suddenly obtained to an alarming degree, ending,

perhaps, in death. All this, M. Heurteloup observes, is owing to the impossibility, under the present system, of regulating the application of the anæsthetic, to remedy which inconvenience he proposes an apparatus of his own invention, consisting of a glass tube, having each of its orifices closed with cork, into which another tube of a smaller diameter is inserted. One of the latter communicates by means of a flexible tube with a reservoir containing chloroform, which is blown into the larger tube by a small pair of bellows. The chloroform passes thence into the tube at the opposite extremity, which ends in a point, leaving the smallest possible aperture for the escape of the vapor. It is through this aperture the patient inhales the anæsthetic, which issues in a conical form, expanding as it rises, and mixing with the air; so that as the apparatus is brought nearer to or removed from the nostrils of the patient the power of the anæsthetic is increased or diminished at will, and the operator may stop or resume its emission by stopping or renewing the action of the bellows.

A correspondent of the London Medical Times writes as follows: Ever since Dr. J. Y. Simpson made the qualities of this powerful agent known, I have been in the habit of using it freely in an extensive general practice; and, although I have used it at least one thousand times, I have never seen the least bad consequences follow from it, and I consider that this success depends greatly on the precaution I take before administering the chloroform; this simply consists in administering a glass of spirits or wine. I prefer the former, even for ladies. The wine, or spirits, seems to exercise no effect on the chloroform, while their stimulating quality keeps up the action of the heart during the time the patient is under chloroform, and prevents sinking. I had occasion, some years ago, to perform a slight surgical operation on a lady who was fearfully afflicted with asthma, and excessively nervous. Her husband being a medical man, objected to the use of the chloroform in such a case, but I assured him that the wine would prevent any evil happening. The operation was performed, the patient saved from the pain of it, and to her great relief she had no return of asthma for a long time, and when it did return she had recourse to the chloroform, which, again for a time, gave her great relief.

NEW ANÆSTHETIC AGENTS.

Several new agents have recently been proposed for replacing ether and chloroform in anæsthesis. The principal of these is Amylene.

This substance is said to have been discovered some fifteen years ago by M. Cahours, though first described in 1844, by M. Balard, professor of chemistry to the Faculty of Sciences of Paris. It is composed of ten atoms of carbon and ten of hydrogen, and bears the same relation to fusel oil or amylic alcohol that olefiant gas or ethylene bear to common alcohol.

It is made by distilling fusel oil, or amylic alcohol, with chloride of zinc. On adding the fusel oil to a concentrated solution of chloride of zinc in the cold, solution or admixture does not take place, but on applying heat they mix and form a homogeneous liquid, which begins to distil at a temperature

of about 266 deg. Fah. On re-distilling the product thus obtained, the ebullition which commences at 140 deg. Fah., rises during the process to about 570 deg. Fah. The most volatile parts of this distillation are to be separated, and agitated with concentrated sulphuric acid, when the amylene in a pure state will rise to the surface. It is colorless, very mobile, and has a low specific gravity (stated by Dr. Snow to be 0·659 at 56 deg. Fah.). Its boiling point is 102 deg. Fah., and the density of its vapor is 2·45. It has a peculiar and disagreeable smell.

Amylene was first applied as anæsthetic by Mr. John Snow, and for a time was recommended as preferable to ether and chloroform in producing stupefaction or anæsthesia, on the special ground that its employment was unattended with danger to the patient, or nearly so. MM. Foucher and Bonnet have, however, in a recent communication, addressed to the French Academy, recorded facts leading to quite a contrary result. In twelve experiments performed on rabbits they have ascertained that the anæsthetic effect of amylene is produced within from three to six minutes after its application. Before stupefaction is produced the animal utters piercing cries and throws its head backwards; its breathing is accelerated, the globe of the eye is strongly injected, and moves convulsively; a tracheal hoarseness always accompanying the above symptoms. The period of insensibility does not last long if the application of amylene be not continued; in the contrary case, however, a complete collapse takes place; the animal, stretched out without motion, obeys every impulse of the hand, and resembles a flabby mass in which breathing is hardly perceptible. This state may last twenty minutes without causing death. The blood drawn from the arteries during this period still preserves its usual color. Animals subjected to the action of amylene for a certain length of time, continue after the operation in a state of stupor and imbecility, which sometimes lasts seven or eight hours; but in none of the cases observed by the authors of the communication has death followed the application of amylene. The conclusions resulting from their experiments are as follows: — 1. Sulphuric ether, chloroform, and amylene are, of all volatile substances experimented on, the only ones that produce anæsthesia. 2. Amylene does not produce stupefaction unless the quantity of air with which it is diluted be very small; but then it acts upon the animal economy, and especially upon the respiratory organs in a manner which may produce dangerous effects. 3. Chloroform has all the advantages of amylene, without the evils which accompany the use of the latter. 4. None of the substances above mentioned produce anæsthesia, whether local or general, when applied to any particular part of the body by injection under the skin.

From these and other results it may be considered as certain, that amylene is no better than aldehyde artificial oil of naphtha, Dutch liquid, and other bodies of the class of ethers, or hydrocarbons, which have been proved to be inferior to chloroform.

Anæsthesis by the Oxide of Carbon. — This gas is used only externally, and on the diseased part. From the experiment by the unfortunate Chenot on himself, we know that internally it is a poison. According to the trials of M.

Tourdis, of the Faculty of Medicine of Strasbourg, and aftewards of Dr. Ozanam, it has no effect when applied to the skin, unless the epidermis has been previously removed. But when applied to the skin from which the epidermis is removed, or to a wound or sore, it acts efficaciously and produces perfectly the anæsthetic effect; and in the cliniss at Strasbourg, satisfactory results have been obtained. We add that ammonia appears to be an antidote to oxide of carbon.

Anæsthesis by Carbonic Acid. — A physician at Paris, Dr. Follin, has recently endeavored to alleviate pain by means of a continued stream of carbonic acid gas. After the discovery of gases by chemistry, towards the close of the last century, medical men in England early undertook to examine the curvative properties of different gases. The first experiments were made by Ingenhousz. He made known that a finger, when the epidermis was removed, had the pain increased by oxygen, but diminished, and after a while removed by nitrogen, carbonic acid, or hydrogen. This fact, according to this author, was then known in France, where it had been first observed.

It was soon after made useful in therapeutics; carbonic acid was recognized as the most effective gas for removing pain, and was employed with success in several cases of ulcers. But from 1794 to 1834, the facts seem to have been forgotten. At the latter date, M. Mojon, Professor at Genoa, proposed the use of this gas anew.

Dr. Follin was led to undertake his experiment from a knowledge of some recent trials by Dr. Simpson of Edinburgh. He has applied a douche of the gas with success for the relief of pain, in the case of three females having an ulcerated cancer of the neck of the womb. Quiet followed the application in a few seconds, and continued, in one case, for ten to twelve hours, when a new applicatlon was required; in a second, eight days; and in the third, an intermediate interval between the other two. There was, however, no curative effect, which is not remarkable. Others have repeated the experiments. The gas must of course be made pure from any muriatic acid vapor, which may be effected by passing it through a concentrated solution of carbonate of soda. Dr. Follin prefers bicarbonate of soda for obtaining the carbonic acid, which he decomposes by means of tartaric acid.

IMPROVEMENTS IN THE PREPARATION OF INKS.

Alzarine Ink. — An ink bearing this name has recently been prepared by M. Leonhardi, of Hanover, by digesting twenty-four parts of Aleppo galls and three parts of Dutch Madder, with one hundred and twenty parts of warm water. The liquids filtered and mixed with 1·2 parts solution of indigo, 5·2 sulphate of iron, and two parts crude acetate of iron solution. The advantages of this ink are, that, 1. It does not contain gum; 2. The tannate is prevented from separating by the sulphate of indigo; 3. Mouldiness is prevented by this addition and by the acetate of iron.

On the Preparation of Writing Ink in Cakes. — After M. Leonhardi had

discovered the mode of preparation of the so-called alzarine-ink, which is particularly useful, he was anxious to prepare it in a form which would allow it to be sent to a great distance and at any time of the year, render its transport convenient, and diminish its cost considerably, but, at the same time, fulfil all the requirements of an excellent article. This is attained by the dry alizarine ink in cakes. The "ink-powders" hitherto found in commerce are not to be compared with it, for they not only possess a different composition, but never dissolve completely to form a clear solution in water, and their employment is attended with so many inconveniences and disadvantages, that they have been given up. Common black ink may indeed be evaporated to dryness, but it leaves a residue which does not again dissolve completely in water, and never furnishes a useful ink by this solution. The recipe for the preparation of the cake ink is as follows:

Forty-two parts of Aleppo galls and three parts of Dutch madder are extracted with a sufficient quantity of hot water; the fluid is then filtered, five and a half parts of sulphate of iron ore dissolved in it, and two parts of a solution of iron in wood-vinegar, with one and one-fifth part of solution of indigo, are added to it. The mixture is evaporated to dryness at a moderate heat, and formed into cakes of a proper size (for instance five inches long, three and a half inches broad, and three-eighths of an inch thick).

One part of this cake-ink dissolved in six parts of hot water, furnishes an excellent writing and copying ink, whilst even with one part of cake ink and ten to fifteen parts of water, beautiful writing inks are obtained.—*Mittheil. des Gewerbe-vereins für das Königr. Hannover.*

A copying ink, for printing with the ordinary copying press, giving off an impression analogous to that of writing ink, has recently been introduced in England. The ink is made of ground nutgalls, fourteen pounds; of sulphate of iron, six pounds; of gum senegal, twelve pounds; of soap, three pounds; of molasses, four pounds; of Prussian blue, three pounds, and of filtered rain fifteen gallons. The nutgalls are boiled three hours in the water, and the clear liquid drawn off. The gum and sulphate of iron are then separately dissolved in the water, and the whole is mixed with the nutgall decoction, and exposed for about three weeks to the atmosphere, when the liquid is drawn off from the deposited matters and sediment. The molasses and soap are now added to the fluid, and the whole evaporated in a water bath, to nearly the consistency of ordinary printing ink, and the lampblack and Prussian blue are then mixed with it. The above ingredients form a black ink; but any other color may be obtained by using corresponding coloring materials.

Dr. Bly recommends the following method of preparing ink: A decoction is made with a pound and a quarter of nutgalls, and as much hot water as will give five pounds of liquid after straining. Then four ounces of indigo powder is mixed with half a pound of sulphuric acid, the mixture left for twenty-four hours, then dissolved in five pounds of water and eight ounces of powdered chalk, and eight ounces of iron filings added. A part of the acid is neutralized by the chalk, and a part by the iron filings, forming sulphate of iron. The solution thus obtained, mixed with the decoction of

nutgalls, gives ten pounds of ink, which does not deposit sediment or turn mouldy, and flows readily from the pen.

CHEMICAL WRITING.

The following is a copy of the specifications of a patent recently granted to M. Solhausen, for a process for producing chemical marks or writing on paper, without using a liquid like common inks, by employing chemically-prepared paper, and a chemically-prepared pencil, style or other-like instrument, to trace, write, or mark on paper, whereby the salts or substances in the pencil and paper, when they come in contact, will chemically unite under hygroscopic conditions at the natural temperature of the atmosphere, and will form visible chemical colored marks or writing on the paper. Hygroscopic conditions are necessary to the process to effect chemical writing; moisture is the agent which enables the salts or substances used to effect chemical union, but no liquid is employed.

To prepare the paper, the common sizing that is used for writing paper is saturated with a salt or salts, or substances of considerable solubility, and which, when dried with the paper, will maintain its dryness and freedom from moisture under ordinary atmospheric changes. Colorless salts or substances are preferred for this purpose, or they may be of such a light tint as not to be different from the color of writing paper. This salt or salts, or substance, is to form the ground for the colored marks or writing to be produced on the paper. Various salts may be used for this purpose, according to the color of the marks or writing to be produced. For instance, to produce blue marks or writing, the paper is prepared with ferrocyanide of ammonium, which is very soluble in water, or with salicylic. To make black marks or writing, indigolic salts, euxanthic salts, and morphine salts are used. To make red marks, meconic salts, kemenic salts, pyromeconic salts, and angelic salts are used. To produce green writing or marks, the paper is prepared with caffeic or themic salts. These salts, either singly or a mixture of those specified for each color, are mixed with the sizing of the paper, which is applied in the usual manner, and the paper is afterwards dried and pressed in the common way. No certain quantity of these salts requires to be described, but about one ounce of any of them is sufficient to impregnate the sizing for about half a ream of common foolscap paper; a lesser quantity being used to produce feebler colors, and more to produce darker shades. Other well-known salts than those specified may also be used, but those named will effect the results herein described — the principal feature of this invention being to produce chemical writing without an ink. The patentee now takes a deliquescent salt, and, for cheapness, he prefers a ferric oxide — the nitrate, chloride, or sulphate of iron, obtained in any of the usual methods. This salt is triturated and mixed intimately with plastic clay, in about the quantities of an ounce of salt to a like quantity, by weight, of clay or similar substance. The ferric clay is then moulded into any desired form to constitute a pencil or tracing instrument, and is afterwards baked in an oven, to drive off the moisture by heat. The heat is continued, at about

212 degrees Fahr., to drive off all the moisture and to harden the clay. When this is accomplished, the ferric pencil or tracer is removed from the oven or other place, and plunged into molten bees-wax, spermaceti, or any substance of similar character, which will form an air-tight coating, and not decompose the ferric salt. The chemical pencil or tracer, thus produced, may be placed between strips of wood, like a common lead pencil, or it may be placed in a metal pencil-case, and the point of it scraped to expose it to the air. The chemically-prepared paper, previously described, is now traced, pressed, or written upon with the pencil or instrument described. The ferric salt in the said pencil, during the act of writing, when exposed to the atmosphere, absorbs moisture; and when it (the ferric salt) comes in contact with the salt or substance in the prepared paper, the salts or substances in the pencil and paper unite chemically (forming double decomposition), producing a new ferric compound in the prepared paper, and thereby producing chemical-colored characters, marks, or writing. Any of the ferric salts named for the pencil will produce the different colors mentioned on paper prepared with the substances heretofore specified for producing these colors. The pencil or tracer may also be made of a very porous substance, which may be steeped in a solution of ferric salt, then dried to expel the moisture, leaving the salts in fine crystals in its pores; it is then plunged into bees-wax, as described, for the above-described pencil, and for the same purpose. Type may be formed in the same manner as the ferric clay pencil described, and chemical printing may be executed without the use of common topical ink, which in some cases may be advantageous. A very porous fountain pencil may also be made, one whose pores will permit fine ferric salt to percolate as it were through them, and be transmitted to the paper in the act of tracing or writing, and impressed on the paper by a hard point on the pencil, to bring the salt or salts in the pencil and prepared paper into contact, when the two will unite under hygroscopic conditions of the ferric salt, and produce the chemical marks and writing heretofore described.

Another method of obtaining the hygroscopic condition necessary to form a chemical union between the salt or substance in chemically-prepared paper and a pencil, without employing a deliquescent salt to produce chemical writing on paper, is to use glycerine as a component part of the chemical pencil or marker. Without the employment of a solution it will afford the same requisite amount of moisture as a deliquescent salt. Paper prepared with starch, as a sizing, will produce blue marks or writing, if it be traced upon with a porous pencil or fountain pencil containing iodine and glycerine — the latter not being present as a liquid, but simply as a hygroscopic agent.

Another method of producing the same chemical marks or writing on paper as those described is, to prepare the paper in the same manner as that first described, and employ a dry salt in the pencil, and supply the hygroscopic conditions necessary to form the chemical union of the chemically-prepared paper and pencil during the act of writing or tracing, by placing a moist sheet of paper under the paper to be written upon; or they may be supplied, after tracing or writing, by pressing a sheet of moistened paper on

the written or traced surface; by either of which acts the salts will receive the necessary supply of moisture to enable them to form double decomposition, and produce chemical marks or writing on the paper. The salt or salts preferred for making dry salt chemical pencil, for producing chemical writing or marking, of the character described, are the tartrate of iron, the hypersulphate of iron, or any of the permanent iron salts.

Heretofore it has been a desideratum to obtain a superior substitute for the common lead or plumbago pencil and the crayon, and also for the method of writing with a fluid-like ink. The lead pencil and crayon only make mechanical marks, which are easily erased; and writing with ink is troublesome, because the pen has to be often replenished.

This improved method or process will produce chemical marks or writing equal to those made by inks; and the method of writing or producing them is as easy as the act of writing with a common pencil. It will be a superior method of writing on books and bills, and making permanent records on paper. It will afford security against alteration of the writing on records, as it will require the specific salts in the pencil and paper to produce a writing similar in color and shade to that which is attempted to be supplanted, changed, or altered, and to that on the part of the document written upon. This process obviates the evils and objections incident to the use of a common pencil or pen and ink.

The patentee claims "producing chemical marks, records, or writing, on chemically prepared paper, as described, by tracing, pressing, or writing with a chemically prepared pencil, style, tracer, type, or other suitable instrument, on such paper, under the hygroscopic conditions herein described, or in any manner substantially the same."

PARCHMENT PAPER.

At a recent meeting of the Royal Institution, Mr. J. Barlow, F. R. S., presented the following communication, on the new product, known as "Parchment Paper," recently invented by Mr. W. E. Gaine.

The compounds of woody-fibre are carbon, hydrogen, and oxygen; the last-named elements being combind in the same proportion as they exist in water. In this respect woody-fibre is identical with starch, dextrine, gum, and sugar. Unlike these substances, it is insoluble whether in water, ether, alcohol, or oil, and much more averse than they are to chemical change. Mr. Barlow called attention to the enormous inconvenience which would arise if water could dissolve cloth, or if vegetable tissues were easily decomposed. It is, however, many years since Braconnot discovered that sawdust, linen, and cotton fabrics, &c., could be made to part with a portion of their constituent hydrogen in exchange for an oxide of nitrogen obtained from the decomposition of the nitric acid with which they were treated. Pelouze afterwards applied this principle in operation on paper; and to the same principle must be ascribed the gun-cotton and collodion of Schönbein. Taking what may be called the gun-paper (Pelouze's paper) as a type of all these substances, Mr. Barlow showed by experiment that it is inflammable and highly electrical, and that in con-

sequence of the substitution of a certain number of equivalents (varying from five to three) of hyponitric aicd (NO_4) for an equal proportion of hydrogen, it becomes fifty per cent. heavier than the paper out of which it was converted.

The surface-action of vegetable fibre in receiving dyes was then mentioned, in order to introduce some researches recently made by M. Kuhlmann, Director of the Mint at Lille. Led to the investigation by the general notion that azotized substances, as wool, silk, &c., are more susceptible of dyes then are vegetable textures, M. Kuhlmann instituted a series of experiments on gun-cotton, both woven and in the wool, by which he discovered that cotton or flax, thus azotized, will not take dye; but that if either by spontaneous, or else by artificially-produced decomposition, the fibre loses part of its nitrous principles, it then actually combines with colors much more energetically than it did while in its natural state. Specimens of the cloth which M. Kuhlmann had experimented upon, and which that gentleman had sent for illustration of this subject, were exhibited. Having reminded the audience that, in all these cases, a change in chemical constitution accompanied the change in physical properties, Mr. Barlow contrasted with the pyroxylized textures of Kuhlmann and the gun-paper of Pelouze, the woven fabrics subjected to Mercer's process, and the *Parchment-paper*, the invention of Mr. Gaine. By acting on cloth with chloride of zinc, tin, or calcium, with sulphuric and arsenic acid, and, especially, by the caustic alkalis in the cold (the temperature sometimes being lowered to $-10°$ Fahr.), Mr. Mercer has obtained many important effects on the fineness and the general appearance of cloth, and its susceptibility of dye. It being known that sulphuric acid, under certain conditions, modified vegetable fibre, Mr. Gaine instituted a course of experiments to ascertain the exact strength of acid which would produce that effect on paper which he sought, as well as the time during which the paper should be subjected to its action. He succeeded in discovering, that when paper is exposed to a mixture of two parts of concentrated sulphuric acid (*s. g.* 1·854, or thereabouts) with one part of water, for no longer time than is taken up in drawing in through the acid, it is immediately converted into a strong, tough, skin-like material. All traces of the sulphuric acid must be instantly removed by careful washing in water. If the strength of the acid much exceeds or falls short of these limits, the paper is either charred, or else converted into dextrine. The same conversion into dextrine also ensues, if the paper be allowed to remain for many minutes in the sulphuric acid after the change in its texture has been effected. In a little more then than a second of time, a piece of porous and feeble unsized paper is thus converted into the *Parchment-paper*, a substance so strong, that a ring seven-eighths of an inch in width, and weighing no more than twenty-three grains, sustained ninety-two pounds; a strip of parchment of the same dimensions supporting about fifty-six pounds. Though, like animal parchment, it absorbs water, water does not percolate through it. Though paper contracts in dimensions by this process of conversion into *Parchment-paper*,

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it receives no appreciable increase of weight, thus demonstrating that no sulphuric acid is either mechanically retained by it or chemically combined with it. It has also been ascertained by analysis that no trace of sulphur exists in the *Parchment-paper*. The fact of this paper retaining its chemical identity, constitutes an important distinction between it and the gun-papers of Pelouze and others. Unlike those substances, it is neither an electric, nor more combustible than unconverted paper of equal size and weight, nor soluble in ether or potash. Unlike common paper, it is not disintegrated by water; unlike common parchment, it is not decomposed by heat and moisture. In this remarkable operation, the action of the sulphuric acid may be classed among the phenomena ascribed to catalysis (or contact action). It is however, conceivable that this acid does, at first, combine with the woody fibre, with or without the elimination of oxygen and hydrogen, as water; and that this compound is subsequently decomposed by the action of water, in mass, during the washing process, the sulphuric acid being again replaced by an equivalent of water; for, as has been before stated, the weight of the paper remains the same before and after its conversion.

Those who are interested in chemical inquiry will recall many instances of physical changes occurring in compound bodies, while these bodies retain the same elements in the same relative weights. The red iodide of mercury is readily converted, by heat, into its yellow modifications; yet, by the mere act of being rubbed, it is made to resume its former color. Nothing is added to or taken from this substance in the course of these changes. The inert and permanent crystals of cyanuric acid are resolved by heat into cyanic acid — a volatile liquid characterized by its pungent and penetrating odor, and so unstable that, soon after its preparation, it changes into a substance (cyamelide) which is solid, amorphous, and destitute of all acid properties. These substances, as well as fulminic acid, (which, however, is known in combination only,) contain carbon, nitrogen, oxygen, and hydrogen, in the same relative proportion. But the closest analogy to the production of *Parchment-paper*, scientifically considered, is perhaps afforded by what is called "the continuous process" in etherification. It will be remembered that, in this process, sulphuric acid, at a temperature of 284° Fahr., converts an unlimited quantity of alcohol into ether and water. In the first stage of this process, as explained by Williamson, it would appear that the sulphuric acid combines with the elements of ether to form sulphovinic acid; and that, in the further progress of the operation, this compound, by coming into contact with a fresh equivalent of alcohol, is, in its turn, decomposed, and resolved into ether and sulphuric acid. The ether distils over together with the water resulting from the decomposition of the alcohol: the sulphuric acid remains in the retort ready to act on the next portion. Here, as in the case of the *Parchment-paper*, the sulphuric acid does not form a permanent constituent of the resulting substance, though it takes so important a share in its production. The strength of this new substance, before alluded to, and its indestructibility by water, indicate many uses to which it may be applied.

It will probably replace to some extent vellum in book-binding; it will furnish material for legal documents, such as policies of insurance, scrip certificates, &c.; it will take the place of ordinary paper in school-books, and other books exposed to constant wear. Paper, after having been printed either from the surface or in intaglio, is still capable of conversion by Mr. Gaine's method, no part of the printed matter being obliterated by the process. *Parchment-paper* also promises to be of value for photographic purposes, and also for artistic uses in consequence of the manner in which it bears both oil and water-color.

ACTION OF TANNIN UPON SKIN.

The first of a series of investigations has been recently laid before the Academy of Sciences, Paris, by M. Payen, undertaken with a view of arriving, if it be possible, at a knowledge of the phenomena which are going on during the operation of tanning, and to establish a theory of this operation, still so obscure to the chemist. In this first part, he has endeavored only to examine thoroughly and show the generality of a fact, which he had observed several years ago. This fact is, that there exist in the skin two portions which present different properties, when they have undergone the action of tannin. One of these is easily disaggregated, soluble in ammonia-water, the other preserves its fibrous texture, and resists the action of the re-agent, although frequently renewed. The saturation of the skin by the tannin takes place long before the time practically required for good tanning; and requires for the two parts much less tannin than gelatine. The compound formed with the tannin, by the less cohesive parts of the skin, when it has been dissolved in ammonia, is changed in dissolving; it undergoes, besides, a considerable loss of nitrogen during its evaporation to dryness. The effects of long-continued tanning cause the gradual solution of the less cohesive portions united with the tannin, and consequently a relative increase of the quantity of resisting fibrous material. The product, in this case, must therefore be both more pliable and more tenacious. The friable soluble portion which remains in the tanned leather is unstable; in dissolving, it may withdraw considerable quantities of the azotized substance; and it is thus, perhaps, that the less cohesive part of the skin is removed during the long operations of tanning. These are, in substance, the remarks which result from the observations and analyses reported in detail by M. Payen. The author proposes to examine successively all the operations of tanning, and to study separately the effects produced by lime, soda, by ammonia, the formation of which is determined by the foregoing bases, by dilute sulphuric and lactic acids, &c. — *L'Institut. 26th November.*

ON THE PREPARATION OF PURE GRAPE-SUGAR.

Commercial honey, as crystalline as possible, is spread upon porous tiles. The white crystalline residue is dissolved in alcohol, and purified by re-crystallization; if necessary, also with animal charcoal. The honey yields about one-fourth of its weight of grape-sugar. — *Journ. fur Prakt. Chem.*

THE PREPARATION OF COLLODION FOR SURGICAL PURPOSES.

For this purpose Hofmann introduces one part of cotton wool into a mixture consisting of twenty parts of the strongest nitric acid, and thirty parts of sulphuric acid, for a quarter of an hour. The operation should be conducted in a glass vessel with a cover, and the cotton stirred frequently by means of a glass rod. The cotton is then well washed, to remove the last trace of acid, and pressed strongly in a linen cloth, and before being dried it should be pulled, to separate the knotty portions. The cotton should now be dried in a sieve over a stove. Six parts of the cotton thus prepared are dissolved in a mixture of one hundred and twenty parts of ether and eight parts of rectified spirits of wine, to which three parts of castor oil are finally added. Hofmann states that this collodion does not crack or contract like that prepared in the usual manner. — *London Lancet.*

ETHER AND CHLOROFORM GELATINIZED.

Professor Rusponi has succeeded in turning ether and chloroform into gelatine, by shaking them with white of egg in a closed receiver. The compound obtained with the ether is semi-transparent; with the chloroform it is white and opaque. This gelatine is soluble in water, and may be spread on linen in the form of a poultice. It will likewise mix with morphine, cantharidine, conicine, &c., and may thus become of great therapeutical use.

DESTRUCTION OF VERMIN BY ANÆSTHETIC AGENTS.

The following is an abstract of a paper read before the Paris Academy, by M. Doyere, on the destruction of vermin by anæsthetic agents applied particularly to the case of insects, or larvæ, in wheat.

Experiments have been made at Algiers on the most extensive scale with these objects, especially to ascertain their effects on cereals. It was ascertained that two grammes of chloroform, or, a sulphurate of carbon per metrical quintal of wheat, was sufficient to destroy, in five days' time, all the insects in wheat; while with five grammes of sulphuret of carbon per metrical quintal, the destruction takes place in twenty-four hours. The mass of grain operated on, so far from being a difficulty, rather simplifies the operation. Experiments were made on 11,600 hectolitres of barley at once; one hundred pounds of the sulphuret of carbon was used, which required twenty minutes to introduce into the mass. These operations may be made successfully even when the heap of grain is simply covered with a water-proof cloth, which is closed with clay near the ground on every side. The grain operated on retains all its germinating properties. The fetid odor of the sulphuret of carbon is soon dissipated; and after it has been exposed two or three days to the air, and moved occasionally with a shovel, no trace of it remains. The grain so treated, when ground and made into bread, cannot be distinguished from grain which has not been exposed to the influence of anæsthetic agents. Animals ate the barley, while it was still fetid, with such an appetite and avi-

dity as to indicate that the odor and the savor it retained were far from being disagreeable to them.

IMPROVEMENT IN THE MANUFACTURE OF PERFUMES.

It has been found that by treating wheat, or its farina, with ether, some waxy or fatty matters are dissolved, which are more or less colored, and almost always have a strong odor; this aromatic principle is very persistent, and may be recognized in the fatty matter after the lapse of several years, disappearing, however, whenever the fat becomes rancid. These facts have been made the foundation of a process devised by M. Millon, a French chemist, for the extraction of the aromatic principle of flowers and of some plants peculiar to Algeria.

To avoid the alterations which flowers undergo on drying, or distillation, M. Millon separates the aromatic part by dissolving it in a very volatile liquid which is afterwards expelled by distillation. With such a solvent, the distillation is attended with no inconvenience, for it may be performed at a low temperature; M. Millon finds that the perfume undergoes alteration whenever a temperature is applied above that of the surrounding atmosphere. In some parts of Northern Africa, the thermometer reaches $+70$ C.; he then employs with success the volatile solvents, such as sulphuret of carbon, ether, chloroform, word-spirit, the point of ebullition in which is below this temperature. He has even succeeded with alcohol, whose point of ebullition is above 70°.

The solvents which succeed best are ether and sulphuret of carbon. The flowers are put into the apparatus, and the ether then poured on so as to cover it. In ten or fifteen minutes the liquid is run off and a new quantity of ether introduced to wash out what is left; this remains as long as the first. The ether dissolves all the perfume and deposits it again on distillation in the form of variously colored residue, sometimes solid, sometimes oily or semi-fluid, yet becoming solid after some time. This residue, when obtained in a thin layer, is fused by the solar heat or an equivalent temperature, and resoftened frequently until it exhales no longer the odor of the solvent.

The solvent, ether or sulphuret of carbon, should have been previously purified with the greatest care. That derived from the distillation may be used indefinitely, provided it is for the same flower and apparatus. Properly managed there is but very little loss of the solvent and the distillation is rapidly performed, much more rapidly and with a larger amount of leaves and flowers than by the ordinary method of distillation. But the gathering of the flowers should be done at the proper time of day for each flower. Thus the carnation gives off its perfume after an exposure of two or three hours to the sun. Roses, on the contrary, should be collected in the morning as soon as well open; the Jasmine before sunrise.

In the distillation, as hitherto carried on, all the modifications of the flowers are mixed in one and the same essence, which corresponds to no one of them, the better portion partly correcting the rest. But with the Millon process, the slightest alteration is apparent in the perfume, and in order to

obtain the freshness and delicacy of the flowers, it is necessary to have them fresh and sweet. The perfection of the flowers determines the perfection of the perfume.

At first Millon operated by shutting out the contact of the air. But now he favors its presence, for he has found that the perfume, instead of dissipating rapidly like the essences, has great fixedness. It is only through contact with other principles of the plant that it undergoes alteration. Once isolated, it is beyond their influence, and experiences no further change. Millon thus for several years has kept perfumes at the bottom of open tubes or capsules open to the air without sensible alteration; and according to him, this fixedness or resistance to atmospheric change is a fundamental characteristic of perfumes.

It has not been possible yet to submit the perfumes to elementary analysis, the flowers furnishing so little of it; a kilogramme giving only a few milligrams of the aromatic principle.

The residue of the operation by ether or sulphuret of carbon contains wax and fatty and coloring matters, and it is very difficult to separate the aromatic principle from them. Alcohol answers best for this purpose. It does not dissolve the waxy part, while it removes completely the odor. operating with alcohol on a grain of the residue, the perfume is taken up with a little oil and the coloring matter, and the aromatic residue will have lost in the process only a few hundredths of its weight.

The perfume is almost indefinitely diffusible in the air, showing its presence by its odor, without any sensible loss of weight. It is equally diffusible in distilled water, when some drops of an alcoholic solution are poured into it; but in ordinary water, the odor is dissipated, showing its easy alterability with reagents.

The facility with which these perfumes dissolve in alcohol, fats and oils, shows the ways in which it may be industrially employed. The essential point is, that the small quantity of product afforded by the flower represents exactly the amount of perfume, and a gramme of residue proceeding from a kilogramme of flowers, aromatizes to the same degree fat, or oil, and under a volume a thousand times less produces the same effects. The process, then, takes the volatilizable part of the flower, concentrates and preserves it, and puts it up for transfer, without loss, to the perfumery shops, where the final preparations are made. Moreover, the work of incorporating the perfume of the flowers with fats and oils, to-day so costly and so incomplete, will be replaced by a simple mixing or solution, which may be done at any convenient time, or place. It is, for perfumery, a new art of extreme simplicity.

ON THE SUGAR OF THE *SORGHUM SACCHARATUM*, OR CHINESE SUGAR-CANE.

At a late meeting of the Boston Society of Natural History, Dr. A. A. Hayes read a paper upon the kind of sugar developed in the Sorghum saccharatum, or Chinese Sugar-Cane, as follows:

The introduction of this interesting plant has led to many somewhat extravagant suggestions, in relation to its future bearing on the agriculture and

commerce of our country, particularly in relation to its produce of sugar. I have therefore deemed it a subject worthy of chemical observation and experiments, to determine its claims as a sugar producer; and have also chosen it to illustrate a uniformity of vegetable secretion, according with well-known natural laws. In order to give scientific precision to the remarks which follow, it is necessary that a brief definition of the term sugar, should be given. So rapidly has chemical science progressed of late, that this well-known term has now become a generic name for a class of bodies, individually presenting us with the most marked diversities of sensible characters and composition. We have sugars which are sweet, others which are slightly sweet, and some destitute of sweetness; some are fermentable, others do not undergo this change; some are fluid, more are solid.

In connection with the present subject, adopting cane sugar as the most important kind commercially, and as an article of food from certain inherent qualities, if we examine into its sources, we find them abundant, but not numerous. So far as observation has extended, its production by a plant is definite; a change of locality, even when accompanied by a marked change in the habit of the plant, does not alter essentially the nature of the sugar it produces. Thus the cane of Louisiana rarely matures and is an annual, while in the soil and climate of Cuba, it enjoys a life of thirty, or even sixty years. The juice of our southern plant always contains more soluble alkaline and earthy salts than is found in the cane of Cuba, but its sugar is secreted as cane sugar. The juice of the sugar beet, of water-melons, and a large number of tropical fruits, the sap of the maple and date palm, afford cane sugar. In these juices and saps, when concentrated by desiccation in the cells of the plants, it always appears in regular, brilliant crystals, of a prismatic form, clear and colorless; distinctly indicating a vital force in the plant, separating it from other proximate principles and leaving it in its assigned place pure.

The class of sugars next in importance, includes under the general term Glucose, a number of sugars having varied characters, which should be separately grouped. Among them are the sugars of fruits, seeds, and grasses; those produced in the animal system, and the artificial sugars made from starch, grains, and sawdust. The varieties of glucose are both solid semi-fluid. When solid they present aggregates of sub-crystalline form, in which the organic tendency to rounded surfaces, is generally seen. The semifluid forms often manifest a disposition to become solid on exposure to air, and they then experience a molecular change, which produces crystals having new relations to polarized light and different physical and chemical characters.

It is unnecessary to enter more minutely at this time, into a description of each variety of glucose, for the individuals of the class are easily distinguished from each other, and most clearly and remarkably from cane sugar. The plants producing the natural glucose sugars, mature their cells as perfectly as those producing cane sugar, and the secretion can be found as distinctly isolated from other principles as cane sugar is, even when the glucose is semifluid. Hence we are able to determine by microscopical observations,

aided by chemical tests, the presence and kind of sugar in the tissues, or sap of a plant, often without incurring the risk of change of properties through the chemical means adopted for withdrawing the sugar.

We have the authority of our associate, Mr. Sprague, for the conclusion, that the *Sorghum vulgare,* or saccharatum, belongs to the tribe including grasses, and we should therefore expect to find its saccharine matter the variety of glucose called sugar of grasses or fruit sugar. The unsuccessful attempts made to crystallize sugar from the juice of the Sorghum, produced in different climates of our country last year, indicated that it contained no cane sugar, or that the presence of some detrimental matter in the expressed juice, destroyed the crystallizable character of cane sugar, as can be artificially done. My observations commenced after I had obtained several specimens of the Sorghum, and have been continued on the semifluid sugar, likewise from different parts of the United States, with uniform results.

When a recent shaving of the partially-dried pith of the matured stalks of the Sorghum is examined by the microscope, we observe the sugar cells filled with semifluid sugar. After exposure to air it is often possible to distinguish some crystalline forms in the fluid sugar. These grains, after being washed, cease to present a clear crystalline character, and have the hardness and general appearance, of *dry fruit sugar.* By withdrawing the sugar without the aid of water, it is possible to obtain it colorless and neutral, as a semifluid glucose or fruit sugar, and no traces of crystals or crystalline forms can be seen. The glucose thus obtained, freely exposed to air, soon undergoes the molecular change which is exhibited by sugar of grapes, and we thus observe another character associating the whole product, with the sugar of grasses and fruits. Leaving the physical observations, and substituting the more exact processes of the laboratory, I found that the semifluid sugar of the Sorghum did not blacken in sulphuric acid, but was sensitive to the action of alkalies, and reduced the alkaline solution of tartrate of copper, thus conforming to the well-known characters of glucose. The most careful trials I could make, failed in detecting cane sugar in any samples of the Sorghum stalks, or in the samples of sugar, including one made by Colonel Peters in Georgia, prepared under the most careful management. I must therefore conclude, *that the Sorghum cultivated in this country does not secrete cane sugar or true sugar; its saccharine matter being purely glucose in a semifluid form.*

As a matter of science this result is interesting, in showing the integrity of character pertaining to the genus in which this plant is botanically placed; the sweet grassed yielding fruit sugar, while the maize produces cane sugar only.

In its economical bearings we might wish that the sorghum secreted cane sugar, for the values of cane sugar and glucose are very different. From the best authorities we learn that the power of imparting sweetness in cane sugar, is between two and one half and three times as great as that of dry glucose, and the semifluid sugar of the Sorghum containing water, nearly four pounds of this will be required, to equal one pound of sugar in ordinary

use. As a raw material for the production of spirit, for which it seems well adapted, the glucose of the Sorghum may prove valuable, and as an addition to a forage crop, the plant may be found to possess a high agricultural importance.

Dr. John Bacon made a statement confirmatory of the results arrived at by Dr. Hayes. He was unable to obtain any crystals of cane sugar.

A private note of Dr. Hayes, received by the editor since the communication of the above paper, states that the *glucose sugar* of the *sorghum*, after extraction and standing several months, takes a crystalline form. The crystals formed resemble those of cane sugar, but the product itself remains a higher grade of dry fruit sugar.

Dr. Hayes also states, that the *sorghum*, when grown in Algeria, undoubtedly secretes *cane sugar* — the climatic influences being altogether different from those to which the plant is subjected in the United States.

ON A NEW APPLICATION OF ALUMINA.

All chemists know the property which hydrated alumina possesses of uniting with coloring matters and forming true combinations commonly known under the name of *lakes*. These compounds, although not yet studied, ought to have, constant composition, for we know certain salts of these coloring matters with other bases; for instance, carmine forms with the oxide of copper a definite substance, and alizarine forms with potash a definite substance; and M. Mené, chemist to the metallurgical establishment of Cruezot, seeing this property and the power of hydrated alumina to decolorize liquids, thought whether its use might not be extended to some more branches of industry.

He prepared the hydrated alumina by decomposing a solution of alum with carbonate of soda, washing the precipitate in a filter. This alumina was mixed with boiling solutions of coloring matters, the alumina always being in excess, and a colored lake was obtained, precipitated at the bottom of a colorless liquid. The experiments were first made upon solutions of litmus and upon carmine, and extended to molasses and colored syrups. The experiments were so successful that the author hopes, owing to the simplicity of the operation, that it will be possible to substitute it, or the salts of alumina, in place of animal charcoal in decolorizing sugars.

To decolorize the syrup of sugar, at present, the syrup is made to flow very slowly through tubes containing large quantities of animal charcoal, and the operation is more or less quick in proportion as the solution is more or less concentrated; whilst by means of alumina there is only one boiling requred, and on leaving the apparatus the sugar can crystallize out of it. A simple cloth filter stops the lakes formed by the impurities of the syrup. The revivification of the alumina salt would be trifling compared with that of animal charcoal. The results of the experiments were as follows:

10 grains litmus were discolored by 250 grains animal charcoal
10 " " " " " 15 " alumina

1 quart of a solution of molasses	by	125 grains	animal charcoal
1 " " " "	"	7 "	alumina
1 " " honey water, brown	"	200 "	animal charcoal
1 " " " "	"	11 "	alumina

There would be a great advantage in this process, owing to the fact that it does not introduce into the liquids operated upon any strange matter capable of altering the product which it is desired to obtain; in truth, the alumina itself is insoluble and insipid; moreover, the lake which it forms with the coloring matters is itself insoluble and insipid.

OXLAND'S METHOD OF REFINING SUGAR.

At the Dublin meeting of the British Association, Dr. Daubeny gave an account of a new method of refining sugar, recently introduced into England by Mr. Oxland, and known by his name.

It consists in the adoption of the superphosphate of alumina in conjunction with animal charcoal, as a substitute for the albumen usually employed for that purpose. In both cases the object is to separate and carry down the various impurities which color and adulterate the pure saccharine principle present in the syrup expressed from the cane or other vegetable which supplies it. As, however, bullocks' blood is the material usually procured for the purposes of supplying the albumen, a portion of uncoagulated animal matter, together with certain salts, is left in the juice in the ordinary process of refining, which impairs its purity and promotes its fermentation — thus occasioning a certain loss of saccharine matter to result. Nothing of the kind happens when the superphosphate is substituted, and so much more perfect a purification of the feculent matters, under such circumstances takes place, that several varieties of native sugar, which, from being very highly charged with feculent matters, are rejected in the ordinary process of refining, are readily purified by this method. The employment of superphosphate of alumina also gets rid of so much larger a proportion of the impurities present in the sugar, that much less animal charcoal is subsequently required for effecting its complete defæcation than when bullocks' blood has been resorted to. The quantity of superphosphate necessary for effecting the object is, for ordinary sugars, not less than twelve ounces to the ton; whereas, for the same quantity, as much as from one to four gallons of bullocks' blood is found to be required. Dr. Daubeny suggested that this re-agent might be advantageously resorted to, not only in the purification of sugar, but also in other processes of the laboratory, when the removal of foreign matters, intimately mixed with the solution of a definite component, becomes a necessary preliminary in its further examination.

COLORING MATTER FROM THE SORGHO.

Dr. Sicard, of Marseilles, France, discovered in the husk surrounding the seed of the sorgho plant two coloring matters combined together in it. One is red and soluble in water, but very soluble in alcohol and ether,

as well as in the alkalies, the other is orange yellow, and soluble in hot and cold water. He has found these coloring matters in the husks of every species of the sorgho plant.

M. Itier, another French chemist, in a paper recently presented to the French Academy states, that he is satisfied that the coloring matters discovered by M. Sicard, are to be found in the stalks, as well as the husks, and can be obtained after all the sugary liquid has been expressed from them. The red coloring matter which M. Itier gets from these sources he names purpuroleine, and the yellow coloring matter he names xantholeine.

ON THE COMPOSITION OF WHEAT-FLOUR AND BREAD.

The following is an abstract of a paper recently read before the London Chemical Society, on the composition of wheat-flour and bread, by Messrs. Lawes and Gilbert:

The authors described the results of an extended course of experiments, in which the wheat was traced throughout from the field to the bakery. The crops under examination were grown each successive year from 1845 to 1854 inclusive. In 1846, which year yielded altogether the most fully matured crops, the proportion of nitrogen was lowest, and in 1853, when the crops were altogether poorest, the proportion of nitrogen was highest. The characters of a highly matured crop are, low proportion of water, low proportion of ash, and low proportion of nitrogen. In reference to the effect of manuring, it appeared that in crops manured with both nitrogenized and mineral matters, there was the best produce and the greatest reduction in the proportion of nitrogen. The character of the ash of wheat, though subject to considerable variations in poor crops, was found in well-matured produce to have great fixity of composition. The character of the ash, moreover, was very independent of the nature of the manure, but it was observed that the proportion of lime increased with the high maturation of the crop. In reference to the produces of the mill, the bran was found to yield ten times as much ash, and one and a half times as much nitrogen as did the household flour. Nothwithstanding the higher per centage of nitrogen, and the large actual amounts of the mineral constituents of the grain contained in the branny portions, the writers of the paper were of opinion that such were the effects of the branny particles in increasing the peristaltic movements of the bowels, and thus clearing the alimentary canal more rapidly of its contents, that it was questionable whether in the generality of cases, more nutriment would not be lost to the system by the admission into the food of the imperfectly divided branny particles, than would be gained by the introduction into the body in connection with these irritating or cathartic particles, of a larger amount of supposed nutritious matters.

The authors estimated the amount of water in bread at from thirty-six to thirty-eight per cent., and considered that 100 pounds of flour yielded on the average 138 pounds of bread. Their experiments showed that the loss of dry matter in fermentation is extremely small, certainly less than one

per cent. It is well known that millers and bakers consider the excellence of flour to be in proportion to the amount of starch. Contrary to the opinion of Liebig, and of most chemical physiologists, the authors maintained that the bakers' standard is the correct one; or at any rate that the least nitrogenized bread contains an ample sufficiency of nitrogen, and that the great demand for food is for its respiratory or carboniferous constituents. From a large number of analyses of flour, in which the gluten was separated mechanically, it appeared that, both in Europe and America, in proceeding from the north to the south, the proportion of gluten gradually increased, and, consequently, according to the authors' criterion of high maturation, the most matured crops were grown in the coldest latitudes.

LACTIC ACID IN VEGETABLES.

Professor Wittstein, a German Naturalist, has announced the discovery of Lactic Acid, heretofore considered of exclusive animal origin, in vegetables, especially in the peduncles of solanum dulcam ara, and in the liquid which dropped from freshly cut vine branches. It would seem the further researches are carried, the fewer distinctions remain between vegetable and animal substances. —*Journal of Medicine.*

ORIGIN OF UREA IN THE ANIMAL ECONOMY.

Dumas has announced with much enthusiasm the confirmation of his views already old respecting the origin of urea in the animal economy, namely, that the urea proceeds from the albuminoid substances destroyed in the blood by an oxydating process. This is now established by M. Bechamp, Professor at the School of Pharmacy of Strasbourg, who has succeeded in changing albumine fibrine and gluten into urea by a slow combination proceeded by means of a solution of permanganate of potash at the temperature of about eighty degrees C. The following is the process:

Ten grams of aluminum are dissolved in 300 grams of water; and to this by degrees seventy-five grams of permanganate of potash are added. The reduction, which is at first very active, soon ceases. It is then heated to forty degrees C. in a water bath, and from time to time saturated with sulphuric acid, yet so as to leave it still a little alkaline. When the discoloration is completed, it is filtered, and exactly saturated with dilute sulphuric acid. The solution, now perfectly limpid, is evaporated in a water bath; and when reduced to a small volume, an excess of concentrated alcohol is added; it deposits some sulphate of potash and sulphate of ammonia. The alcoholic solution is evaporated in its turn to the consistence of honey and treated with hot absolute alcohol, which dissolves the urea.

Whilst M. Bechamp was bringing out this transformation, a physiologist, M. Picard, made, also at Strasbourg, some observations bearing on the subject, having reference to the presence of urea in the blood and its diffusion through the system.

It is known that according to MM. Dumas and Prévost, urea shows

itself in the blood of animals after the removal of the kidneys, and that they conclude from the fact that the kidneys remove the urea, while not producing it.

M. Picard has completed the demonstration. He has compared, as regards the presence of urea, the arterial and venous blood by precipitating the urea with nitrate of mercury. The renal artery of a dog afforded 0·0365 per cent of urea, and the renal vein only 0·0186 per cent. In studying the question with reference to man, he has observed that the arterial blood which passes into the kidneys leaves there about twenty-eight grams of urea; while the quantity of urea in the urine of the subjects submitted to experiment, varied between twenty-seven and twenty-eight grams for the twenty-four hours. This proves that the kidneys remove but do not make urea, as announced thirty-five years since by Prévost and Dumas.

ON UREA AS A DIRECT SOURCE OF NITROGEN IN VEGETATION.

At the Dublin meeting of the British Association, Professor Cameron showed that nitrogen was as available as food for plants, when a constituent for urea, as in its ammoniacal combination; or, in other words, that urea, without being converted into ammonia, may be taken up into the organisms of plants, and there supply the necessary quantity of nitrogen. He described the experiments which led him to this conclusion, which were very elaborate, and were made on barley plants, in circumscribed spaces, and where the air was, in consequence of being treated with dilute sulphuric acid, rendered free of ammonia, the barley having been sown in a soil which was constituted of felspar, and an artificial manure, containing substances derived from the ashes of the barley plant. To some of the earthen vessels in which the barley was planted urea was supplied, and to others sulphate or ammonia, and some were left without any nitrogeneous matter whatever. In the two former instances the results were equal — they both arrived at maturity simultaneously — and the ears were equally developed. The instances in which no nitrogenous substance was used merely germinated, small stems appeared, but no ears were produced. The deductions from the foregoing were thus enumerated by Dr. Cameron, — 1. That the perfect development of barley can take place, under certain conditions, in soil and air free of ammonia and its compounds. 2. That urea in solution is capable of being taken into the organism of plants. 3. That urea need not be converted into ammonia before its nitrogen becomes available to promote the process to serve the purposes of vegetation. 4. That the fertilizing effects of urea are little, if at all, inferior to those of ammoniacal salts. 5. That there exists no necessity for allowing drainings or other fertilizing substances containing urea to ferment, but on the contrary, greater benefits must be derived from their application in a fresh or unfermented state.

FUNCTION OF SALT IN AGRICULTURE.

Mr. A. B. Northcote has communicated to the London Philosophical Magazine, a paper of experiments undertaken to ascertain the *rationale* of

the action of salt in increasing the fertility of certain lands. We have not space for details, but quote Mr. Northcote's conclusions: — "The results, then, at which we must arrive are, that agricultural salt is a most energetic absorbent of ammonia, both in virtue of its chloride of sodium and of its soluble lime-salt, and that the proportion of the latter especially most powerfully affects its action; but that at the same time its agency does not seem to be altogether a permanent one; it will collect the ammonia, but it is questionable whether it can retain it for any great length of time, because in the very decompositions which happen in order to render the ammonia more stable, salts are formed which have a direct tendency to liberate ammonia from its more fixed combinations. It may, however, retain it quite long enough for agricultural purposes; if the young plants are there ready to receive it, its state of gradual liberation may be for them the most advantageous possible; and to this conclusion all experiments on the large scale appear most obviously to tend. It is described as an excellent check to the too forcing power of guano; and from M. Barral's experiment we see that it either prevents the too rapid eremacausis of the latter, or stores up the ammonia as it is formed. As a manure for growing crops, all experience and all theoretical considerations therefore show it to be most valuable; but when employed to mix with manure heaps which have to stand for considerable periods of time, theory would pronounce, as practice has in many cases done, that its power of retaining ammonia under those circumstances is at the best doubtful."

NOTES ON ALUM IN BREAD AND ITS DETECTION.

At a recent meeting of the London Chemical Society, a paper was read by Mr. Hadow, upon the above subject.

After detailing two processes which have been put forward for the examination of bread for alum, Mr. Hadow stated that, wishing to test these processes, he had a loaf prepared by a baker, into the dough of which had been put the large quantity of eighty grains to the quartern loaf. After baking, the loaf was broken into pieces, and macerated with successive quantities of water, and the whole afterwards filtered; a clear liquid was obtained, a portion of which was tested with chloride of barium and with ammonia, and a precipitate obtained in each case. The remainder of the liquid was evaporated to dryness, and the residue, ignited to burn off any organic matter, was dissolved entirely by water and dilute nitric acid. Pure potash added to this solution gave a dense precipitate, insoluble in an excess of the potash. The filtered liquid from this precipitate, after the addition of chloride of ammonium in excess, remained perfectly clear, showing the total absence of alumina.

The bread, after maceration, was incinerated, and the ash dissolved in dilute nitric acid, and the solution treated with pure potash in excess, a precipitate was left, which was removed on a filter, and the filtered liquid on addition of chloride of ammonium gave a large precipitate of alumina.

From these results it will be seen that macerating the bread in water does not dissolve out any alum from it, and that from any experiments made in

this way for the detection of adulteration with alum, the results must be quite fallacious. Many experiments have been made in this way, namely, by the macerating process, and some persons who have done so have given testimony that they have found alum in the bread; but it must be clear that they were satisfied with simply testing the watery liquid from the bread by the chloride of barium and the ammonia, and concluded that the precipitates they obtained were from the sluphuric acid and alumina of the alum. By experiment it was ascertained that a much larger amount of alum might have been added to the bread than was done in this case, and the same conclusions arrived at.

These results prove that the alum is decomposed in the baking of the bread; the alumina of the alum combining with the phosphoric acid of the phosphates already in the flour, forms phosphate of alumina, a salt perfectly insoluble in water.

Objection was made to the other process, which was to incinerate the bread and dissolve the ash in dilute nitric acid, and test for the alumina in the solution, on account of the very long time before the organic part of the bread is burnt away; and it was proposed to simply char the bread, and afterwards to deflagrate the coaly mass with nitre, and then to add water only; the carbonate of potash formed by the deflagration of the nitre, dissolves up, and along with it nearly all the alumina, alumina being very considerably soluble in a carbonate of potash solution, and from which chloride of ammonium in excess will precipitate it.

Another process for detecting when alum has been used in the baking of bread, founded upon the mordanting properties of the salts of alumina, was given, and it was said to be accurate, and if so it is easy; it is simply to immerse for a few hours a piece of the suspected bread in a fresh and dilute decoction of logwood, made with ordinary pump water; pure bread is said to be superficially stained by the pale orange-red color of the decoction, whilst alumed bread is dyed a purple color, and to some depth.

It was stated it was difficult to judge of the quantity of the alumina simply by the eye, since its appearance varies much with the mode of its precipitation.

ON THE CHEMICAL PROPERTIES OF THE POTATO.

At the last meeting of the British Association Mr. J. W. Rogers presented a paper "on the chemical properties of the potato, and its uses as a general article of commerce if properly manipulated," the object of which was to show that the matter of the potato was in reality equal in nutritive value to the dry matter of wheat, whilst the quantum of food produced from a given quantity of land was nearly four times that produced from wheat. He exhibited some interesting specimens of the production of the potato in meal, flour, etc., and gave the following results of analysis: —

	Starch.	Gluten.	Oil.
	lb.	lb.	lb.
Components of the potato per cwt.	84·077	14·818	1·104
Do. of wheat	78·199	17·536	4·265

And gave the following important fact as to the quantum of food from an acre of land: —

	Starch.	Gluten.	Oil.
Dry matter of potato	3,427 lbs.	604 lbs.	45 lbs.
Dry matter of wheat	825	185	45

Thus the total nutriment from an acre of land is —

From the potato	40·76 lbs.
" " wheat, per cent	10·55 lbs.

The preparations of meal and flour, prepared from the potato, and exhibited by Mr. Rogers, appeared to be almost alike in appearance to wheaten flour and meal, and excited much interest.

ARTIFICIAL MILK.

For some time a liquid has been prepared which is said to have so far the qualities of milk that it is called artificial milk or "lait-viande." It is prepared as follows. Into a Papin's digester three kilograms of fresh pounded bones are put and one kilogram of meat, with five or six times as much of water. The top is hermetically closed; double sides surround it, and in the cavity between, a current of steam circulates which raises the temperature of the digester up to 140 deg. Fah. At the end of forty minutes after reaching this temperature, a stop-cock with a small orifice is opened which lets out a vapor having the odor of broth; but some seconds after, there issues a white liquid which is nothing but the artificial milk. After this milk has passed out, the digester contains only the meat, the boiled bones, and a soup of inferior quality. The artificial milk resembles milk in color, consistence, odor, and even taste. But in composition it is different; for it is only an emulsion produced by the fat mixed with the water by means of the gelatine. Although the name artificial milk is not proper, it has some nutritious qualities, and for this reason it is now under trial at the hospitals of Paris.

USE OF ARSENIC IN STEEPING GRAIN FOR SEED.

Boussingault has communicated to the Annales de Chimie some experiments on the use of arsenic in steeping grain for seed. This process has two objects, the one to protect the harvest from disease, the other to prevent the seed from being devoured by vermin. The substances generally used are salt, glauber salt, lime and sulphate of copper. But although these may hinder the development of cryptogamic sporules, they have little effect in preventing the seed from being eaten. The greatest part of the substance used remains in the husk, which the animal rejects.

The most effectual means is the employment of arsenic; this not only preserves the seed from decay, but if eaten by the vermin, it destroys them, being so strongly poisonous. By using arsenic in a soluble form, such as the arsenite of soda, it may be added to the grain in perfectly definite proportions.

Boussingault's process is as follows: — A solution of arsenite of soda is prepared, which contains fifty-seven grammes of arsenious acid in the litre. Of this arsenical solution, three and a half litres are taken and added to twelve and a half litres of water. A hectolitre of corn is placed in a large tub, and these sixteen litres of mixture are added, the corn being continually stirred. In about an hour the whole of the liquid is absorbed, and the grain is then dried. It is, of course, necessary to exercise extreme care in using the arsenical solution, and it is well to color it strongly by the addition of sulphate of iron and prussiate of potash, so that its presence would be readily betrayed.

This steeping is not an unprofitable affair, for it first effectually preserves the harvest, and, secondly, by killing the vermin which might devour it, converts them into useful manure.

ON SOME PRINCIPLES CONCERNED IN DYEING.

M. Kuhlmann having remarked that when eggs were dyed, some of them took colors better than others, and that this fixation of the color took place without any mordant, was led to suppose that, in these cases, the fixation was not due to the calcareous salt, of which the egg-shell is formed, but to the azotized coating upon its surface. This supposition was verified by experiment. As the coating of the egg-shell is very analogous to albumen, this latter substance, coagulated by heat, was tried separately in baths of Brazil wood, etc., and its absorbing power thus shown. M. Kuhlmann then tried the use of this substance, for the purpose of increasing the absorbing power of different tissues; he obtained very favorable results with cotton, less distinct with silk, scarcely perceptible with wool; these trials were made with Brazil wood, madder, and campeachy wood. After albumen, he tried with the same success milk and caseum, which may be coagulated on the surface of the tissues by means of an acid. Milk, especially alone or in connection with mordants, gave the cotton very full colors. He experimented also upon gelatine coagulated by tannin, and obtained results, although feeble, without mordants. He also showed that albumen may serve as a medium for precipitating upon stuffs, metallic oxides, with which it forms insoluble compounds; in dyeing, stuffs impregnated with these compounds, absorb colors with more ease than if they had been prepared with albumen, or with the same metallic salts alone. Analogous results were obtained with tannin-gelatine. — *L'Institut.*, 26*th Nov.*

ON THE PRESENCE OF FLUORINE IN THE BLOOD.

M. Nickles, in a communication to Silliman's Journal, states that having established the much-contested question of the existence of fluorine in the bones, "I next looked for it in the blood — the only means by which it could penetrate into the osseous tissues. I have found there notable proportions, not only in human blood, but also in that of several Mammalia, (as the sheep, ox, dog,) and several birds (the turkey, duck, goose, hen)."

Results so concordant, seem to give to fluorine an importance which it has not yet had in medicine and physiology. They set aside the opinion of Berzelius that the presence of fluorine in the bones is purely accidental and not in any case a necessary ingredient. If we wish other proof of the necessity of reconsidering the conclusion of this illustrious chemist, we have them in the following facts: that flourine exists in the bile, in the albumen of the egg, in gelatine, in urine, in saliva, in hair; in a word, the animal organization is penetrated by fluorine and it may be expected to be found in all the liquids which impregnate it.

In view of these facts, which I have verified with exactness and all possible care, it is evident that fluorine plays in the blood and other liquids of the system a physiological part. Its absence or its diminunition must constitute of itself a state of disease, a species of chlorose from the absence of fluorine, analogous to the chlorose from the absence of iron. This disease may be detected no doubt by a chemical examination of the urine or saliva, and may be met by a fluorid preparation. Thus far, my own experiments have been made only on normal urine, from an adult in perfect health or from healthy children.

EXPERIMENTS ON DIGESTION.

An opportunity has been recently afforded to Dr. F. S. Smith, Professor of the Institutes of Medicine in the medical department of Pennsylvania College, of examining and re-experimenting upon St. Martin, the Canadian, with a fistulous orifice in his stomach. This opening, which was occasioned by a gun-shot wound at an early period of his life, has never healed, although the surrounding wound cicatrized readily. The original experiments and observations made on digestion, by the late Dr. Beaumont, by the aid of this man, are familiar to every physiologist. The experiments undertaken by Dr. Smith, were made with a view of settling several undetermined questions relating to the physiological action of the stomach, particularly that of the nature of the acid contained in the gastric juice. It must be premised that the analyses were made upon the fluids obtained from the stomach while digestion was in progress.

In every instance, and with all the kinds of food employed, the reaction of the fluid of digestion was distinctly *acid* to litmus paper, while that of the *empty* stomach, (as shown by the introduction of test papers through the fistulous orifice), and of the fluid obtained by mechanical irritation, was as distinctly *neutral*. The *temperature* of the stomach, while digestion was in progress, was about 100° to 101° Fahr. When empty, about 98° to 99° Fahr.

The general conclusions arrived at, by Dr. Smith, from a great number of experiments, are as follows:

1st. That the secretions of the stomach, when digesting, are invariably acid.

2d. That the acid reaction was not due to the presence of phosphoric acid.

3d. That *if* hydrochloric acid was present, it was in very small quantities.

4th. That the main agent in producing the characteristic reaction was *lactic acid.*

Important observations were also made by Dr. Smith upon the influence of the gastric juice upon the various alimentary principles. These observations, which do not admit of sufficient abridgment for republication in these pages, may be found in a memoir recently issued by Dr. S. on this subject.

ON THE USE OF PURE CARBON AS A MEDICINE.

At the Dublin meeting of the British Association much interest was excited in a theory brought forward by Mr. Jasper Rogers, in favor of the use, medicinally, of a pure carbon, which possesses the power of absorbing many volumes of gases which act injuriously upon the human system. He exhibited several preparations prepared for this purpose from carbonized peat, and testimonials of their value from eminent medical authorities.

EXCRETORY PRODUCTS OF LONDON.

Taking the adult population of London at 2,000,000, and assuming that all the solids secreted by their kidneys are carried into the Thames, the river must hold in solution, or have suspended in its waters, a mean daily supply of one hundred and eighty-one tons of solid urinary products. The quantity, however, varies with the weather; for, according to the above results, the Thames will contain ten tons more on days when the readings of the barometer and thermometer are decreasing than when they are increasing; a daily mean of three tons more when the humidity of the air is decreasing than when it is increasing; seven tons more on ozone days than when there is no ozone; about ten tons more with south than with north winds, and a daily mean of seventy-five tons more during calm and gentle variable breezes than when there is a current of air. Let agriculturists bear in mind, that from the action of the kidneys alone of a London population, 66,016 tons of British guano are annually swept into the Thames. — *Dr. Moffatt, in Medical Times and Gazette.*

AMMONIA IN DEW.

M. Boussingault has communicated to the Academy of Sciences of Paris, some interesting determinations as to the quantity of ammonia contained in dew. The dew collected on six different nights between the middle of August and the end of September, at Liebfrauenberg, contained on an average 4·92 milligrammes per litre (about 0·3 grain per gall.) This shows the nutritive effects of heavy dews. M. B. also showed how this ammonia was absorbed by porous substances. The following substances pulverized and exposed to the air for two or three days, absorbed the amounts of the gas noted.

Brick,	0·0000005.	Sand,	0·0000008.
Phosphate of lime,	0·0000008.	Wood, charcoal,	0·0000029.

Repeating his experiments in Paris, obtaining the dew artificially by condensing the moisture of the air upon a cold cylinder of metal, he obtained

10·8 mm. per litre (or 0·66 gr. per gall.) of ammonia, and traces of nitric acid. This experiment shows that the atmosphere of our cities is more strongly charged with ammonia, than that of the country.

ON THE USE OF BICHROMATE OF POTASH FOR PRESERVATIVE SOLUTIONS.

A correspondent of the Medical Times and Gazette says: — This salt, in the proportion of about four grains to an ounce of water, constitutes a solution quite equal to alcohol in its antiseptic powers, and which costs only about twopence a gallon. It will deprive a specimen already partially decomposed, of all odor, and preserve it for any length of time. As, instead of hardening, it a little softens tissues immersed in it, it has a great advantage over both alcohol and Goadby's solution, for all objects which are intended to be re-examined, especially if the microscope is to be used. Preparations long kept in it become of a light olive green color externally, but retain most perfectly their natural appearance at a little depth from the surface. The change of color in the case of red structures, such as muscle, may be prevented by the addition of a little nitrate of potash. In the same way, if it is desired, the softening may be prevented by the use of alum. Unless in combination with both the two last-named ingredients, it is scarcely adapted for a permanent solution. The great advantage over all others, is, in respect to specimens intended to be kept for limited periods, either for private dissection or for exhibition. These intended for the microscope are far less spoiled by it than by any other which I am acquainted with. The only odor which it gives to specimens is a very peculiar one, resembling that of new kid gloves. The cheapness and efficiency of this salt will, I think, make it quite a boon to pathologists.

WATERS OF ARTESIAN WELLS.

On examining the waters of the Artesian well of Grenelle, with reference to the gases present, M. Peligot has ascertained that they contain not the least trace of air. Subterranean waters ought therefore to be *ærated* before being used as an aliment, and accordingly they are about to construct at Grenelle a species of tower, from the top of which the water will descend in innumerable threads, so as to present as much surface as possible to the air.

RESEARCHES ON THE PRODUCTION OF OZONE.

M. de Luca, in a communication to the French Academy, states, that, having found that by passing humid ozonized air over potassium and pure potassa, he obtained nitrate of potassa, which could be separated from the alkaline solutions by means of crystallization; he desired to ascertain whether the oxygen disengaged from the leaves of plants by the action of solar light, or the air which surrounds plants during vegetation, presented the characters of ozone. As the result of his researches, M. Luca says, that he *has not obtained* results which agree in many trials and experiments made with leaves, whether detached or not detached from several plants, or with

entire plants, or in the neighborhood of extensive vegetation. Generally the litmus paper has become discolored, but starched or iodurctted paper only takes a blue color under certain circumstances. Thus, with many of the cactus family, the starched iodurctted paper does not become colored; it is sometimes colored by the action of light in the presence of the green leaves of herbaceous plants, more rarely with the leaves of rose-trees, frequently in contact with or in the neighborhood of moss, very rarely in an inhabited locality.

Not being able to draw any certain conclusions from these results, and as the ozonomical paper is a very unfaithful re-agent, and liable to become colored under the most various conditions, M. Luca tried some comparative experiments upon the air surrounding a great many plants kept in a hot house, and the free atmospheric air in a locality far removed from vegetation. For this purpose he arranged an apparatus in the hot-house of the Botanic Garden at the Luxembourg. An aspirator caused the air to pass slowly during the day, first into two glass tubes full of carded cotton, then into sulphuric acid, then over potassium, and finally into dilute solutions of pure potassa. The examination of the acid and alkaline solutions after six months from April 1856, gave the following results:— The sulphuric acid contained ammonia, in considerable quantity; in the alkaline solutions, to the number of three were found; in the first, the reactions of nitric acid, and some small crystals of the nitrate, and in the other two, the reactions of nitrates, but no crystals.

A similar apparatus, arranged at the same time in the court of the laboratory of France, a place cut off from vegetation, gave the following results: Ammonia was found as before in the sulphuric acid of the apparatus, which undoubtedly proceeded from the atmosphere; but it was impossible to find the least trace of nitric acid in the alkaline solutions.

These facts show that the alkaline solutions do not produce nitrites during the day with a current of air containing ammonia, when this current is far away from vegetation, and that, on the contrary, the air of a hot-house, in which are a great many plants of all kinds, produces nitrates with alkaline solutions, even after passing through sulphuric acid, and thus deprived of ammonia. Is this because plants act like porous bodies on the elements of nitric acid contained in the atmosphere? Direct experiments made far from vegetation with porous bodies of mineral origin prove the contrary, for they do not produce nitrates.

The experiments of Messrs. Andrews confirm the opinion that ozone, far from being a per-oxide of hydrogen, is only modified oxygen, capable of being estimated with the utmost precision. On the other hand, the phenomena of oxidation which ozone produces are not rare, and we know how to take advantage for chemical analysis, of oxonized essence of turpentine, of the ozone produced during the combustion of ether in contact with platinum, etc. We know, likewise, that urea is formed in the animal economy; and M. Béchamp has proved that this body may be produced artificially by the oxidation of albuminoid substances, by means of hypermanganate of potash.

It is not improbable that the oxygen of the air introduced into the economy by the phenomena of respiration and retained condensed or modified by the globules of the blood, in the presence of an alkaline matter, is found in it, at least in part, in the state of ozone, like oxygen dissolved in essence of turpentine, and consequently in a state to produce the same phenomena of oxidation. These views are supported by some experiments made with permanganate of potash, the oxygen of which being disengaged by sulphuric acid, presents the properties of ozone, even at a low temperature, and the latter investigations of Schonbein relative to the property presented by the juice of certain champignons to transform oxygen into ozone.

"If we now wish to examine these facts so as to explain the results which I have obtained," says M. Luca, "we should be tempted to imagine that the oxygen which is disengaged from the leaves of plants by the action of light contains ozone, or that the air which surrounds plants is partially ozonized, and that this ozone, although in small quantity, produces the oxidation of the nitrogen of the air to form nitric acid in the same way that ozone artificially prepared, produces nitrates with the alkalies. The question of the absorption of nitrogen by plants would consequently be reduced to a pure and simple absorption of a nitrogenous compound, such as nitrate or carbonate of ammonia, this carbonate being formed in the atmosphere, and the nitrate being produced under the influence of vegetation. But the above facts are not sufficiently numerous to render them indisputable facts. They require repetition under different conditions, and longer and unremitted study. — *Comptes Rendus.*

Action of the Oxides of Nitrogen upon Iodide of Potassium and Starch. — M. Béchamp states that,

1. The ozonometric paper is not rendered blue by pure dilute nitric acid, but that it is colored by acid containing nitrous acid.
2. Nitric acid and hydriodic acid do not react in cold solution.
3. Iodide of potassium reduces nitrous acid to nitric oxide.
4. Carbonic acid does not displace nitrous acid from nitrate of potash.
5. Nitrous oxide and nitric oxide do not liberate iodine from iodide of potassium.

Observations on Ozone in Canada. — At the Montreal meeting of the American Association, Mr. Chas. Smallwood presented the result of nearly six thousand ozone observations, including a series taken during 1854, the cholera year. These observations were made at his residence, at St. Martins, in Canada. This place is situated one hundred and eighteen feet above the level of the sea, about nine miles due west of Montreal, and about the centre of the island of Jesus, which is surrounded by the two branches of the Ottawa.

The method of observing ozone, was by the ozonometer, consisting of slips of paper wetted with a solution of starch, and iodide of potassium, in the proportion of one drachm of starch to one ounce of water, with ten grains of iodide of potassium. This must be kept dry and free from light till wanted, when it was to be exposed to the light, but excluded from the sun's rays. The amount of ozone in the atmosphere was estimated in

tenths; the extreme blue with which the paper was tinged when the ozone was plentiful, being called ten, diminishing to zero, as the shade became less strong. The presence of nitric acid would also mark this last paper. It had been said that slips of this paper exposed at a high altitude had exhibited a deeper shade than those exposed simultaneously at a lower one. His observations did not corroborate this idea, though he had exposed slips at a height of eighty feet, and others at a height of only four feet, from the ground. He suggested, for the sake of uniformity and comparison, that five feet should be the standard altitude in future observations. The presence of ozone was usually accompanied by a low reading of the barometer, which continues during the continuance of the presence of the ozone; and was usually also accompanied by rain or snow. He had traced ozone in the atmosphere with the thermometer at 20° below, and 80° above, zero; but in general it was in large quantities in the air during falls of rain and snow. The cyclometer was a sure indication of ozone, and a moist atmosphere seemed necessary for its generation. He was, from this circumstance, led to compare the presence of ozone with the precipitation of rain or snow, and he had these results. During the last seven years there were 918 days with rain or snow, and 816 days when ozone was indicated. In 1850 there were 150 days with rain or snow, and 110 with ozone; in 1851, 123 days with rain or snow, and 135 days of ozone; in 1852, 136 days with rain or snow, and 152 days with ozone; in 1853, 136 days with rain or snow, and 114 days of ozone; in 1854, the year of cholera, 133 days of rain or snow, with only 73 days of ozone; in 1855, 140 days of rain or snow, and 100 of ozone; in 1856, 144 days of rain or snow, and 144 of ozone. The days marked were in all cases those in which the ozone exceeded 5°. The small amount of ozone present during the year 1854, favored the idea of a deficiency of that principle in the atmosphere during the prevalence of cholera, and the deficiency occurred during almost every month of the year, though the days of rain or snow were not below the average number. Here seemed to be a confirmation of the opinion that there was a deficiency of ozone during the prevalence of this epidemic. Southerly and easterly winds, from which rain and snow usually came, were generally accompanied by indications of the presence of ozone, while northerly or westerly winds seldom led to its development. During its presence there was no special condition of the atmosphere appreciable by instruments, except the existence of moisture. Schonbein thought it depended on the electrical condition of the atmosphere; but, from 6,000 observations, he had not been able to establish that fact. Nor was its presence always simultaneous with the Aurora Borealis, as had been supposed. The fact that a moist atmosphere was necessary for its development, might account for its being developed in greater quantities near the sea than elsewhere.

ON THE CORROSION OF FRESH-WATER SHELLS.

At a meeting of the Boston Society of Natural History, in 1856, Dr. Weinland made the following remarks upon the Corrosion of the Shells of Fresh-water Clams:

It is generally believed and stated in the books, that the corrosion of the shells of fresh-water clams, which is observed upon the beak, and which frequently extends over the whole surface of the shell, as in Unio complanatus, Anodonta implicata, and Lampsilis radiata, for instance, is effected by the dissolving properties of fresh water when impregnated with carbonic acid. It is supposed that the carbonate of lime is converted into the bicarbonate, and in this state dissolved by the water. This process may sometimes take place, but it does not seem to be the commencement of the corrosion. In all the specimens of Anodonta implicata which he had collected at Fresh Pond (about sixty), he found little holes, or channels, from one to three lines in length, piercing the epidermis, and presenting sharp edges, such as would not have been likely to result from a chemical process. Moreover, he found in many of these holes small worms, and therefore he was inclined to suppose that they commence the process of corrosion in the shell; that they perforate the epidermis, and after the removal of this, the chemical process above alluded to may take place. How far the same supposition may prove true with regard to sea-shells he was not prepared to say.

At a subsequent meeting of the Society, during the past year, a communication on the same subject, suggested by the remarks of Dr. Weinland, was presented by Dr. James Lewis, of Mohawk, N. J. In this communication Dr. L. says:

Although I assent to the propositions of Dr. Weinland, as being sufficient to explain the subject in some instances, I have not regarded the presence of small worms on shells, nor the presence of carbonic acid in water, as sufficient to account for the great diversity of appearances presented by the same species in different localities.

From what information I have been able to obtain in relation to the geological characters of various regions in which shells are found, it appears that those bodies of water having large quantities of calcareous salts in solution produce shells very little liable to erosion; while on the contrary, where there is very little lime, and the water holds in solution considerable quantities of saline, alkalies, and ferruginous salts, the shells are very liable to be eroded. Among the numerous specimens that I have, illustrating the above, are large numbers of shells from streams in Georgia, where the waters abound in saline alkalies. The shells are very generally eroded. I have also shells from other regions where the saline alkalies are more abundant than lime, and they present the same character.

I have also shells from Ohio, Illinois, Wisconsin, etc., which are from streams abounding in lime, and an eroded specimen is seldom to be seen among them, except, perhaps, a few aged shells that are evidently worn by long contact with abrading surfaces of other bodies.

I have also shells from a lake in Herkimer county, N. Y., nearly all of which have perfect beaks, and the few that are eroded are by no means as *chalky* in their texture as some specimens I have seen from localities deficient in lime. The bottom of the lake, in the instance specified, is a bed of marl.

But more satisfactory proof that the freedom of shells from erosion depends on the relative proportions of various salts or alkalies in solution in

the water, is presented in a limited body of water, under my own immediate inspection.

Near the village of Mohawk, is a slowly-moving body of water, in which considerable numbers of shells are found. In those portions of this body of water where the various salts bear their natural and proper relation to each other, the shells are very perfect and generally free from erosions. But at, and below, where the refuse ashes from an ashery are drained or leached into this body of water after every shower, a considerable quantity of saline alkali finds its way into the water, where, in consequence of its specific gravity, it falls to the bottom, and every shell within reach of the influence of this alkaline matter, is more or less eroded, and most of them very much so. But further down, the shells grow more perfect, probably in consequence of the dilution of the alkalies, and their more general diffusion in the whole body of the water, by the influence of the slight current in it.

It may be thought strange that the presence of saline alkalies in water is urged as the cause of the erosion of shells, but it may be explained in this way. Where two or more alkalies are present in the food of an animal, and only one of them is necessary and proper to enable it to perform its healthy functions, the others may, in part, take the place of the proper substance, and if so, the shell formed under such circumstances would be more or less liable to erosion, in proportion to the solubility of the substituted materials.

We have now only to inquire respecting a locality producing eroded shells, — Is the water so highly charged with lime, that the presence of a more soluble alkali in small quantity can have no material influence in the *formation* of the shells? If the answer be yes, then we may reasonably ascribe the eroded character of the shells of such a locality *entirely* to minute parasites; but if there be a preponderance of saline alkalies in the water, they may be reasonably expected to enter into the organization of the shells, and a very slight abrasion of the epidermis of the shell from *any cause*, would expose the soluble alkalies to the solvent action of water alone, and the remaining portion of the shell becoming less dense (and "chalky") by a removal of a portion of its substance, would, of course, wear away very rapidly. It is easy to understand why the beaks of bivalves, and the apices of univalves are first attacked by the erosive process. Firstly, the epidermis is thinner at those points: secondly, those portions of the shell formed in early life may be presumed to contain more gelatinous, and less calcarious, matter than the parts formed at or near maturity. I do not know demonstratively that this is the case, but analogy teaches it.

GEOLOGY.

RECENT PROGRESS IN GEOLOGY.

Of the geological changes still in operation, none are more remarkable than the formation of deltas at the mouths of great rivers, and of alluvial land by their overflow. Of changes of the latter kind, perhaps the most remarkable is the great alluvial deposit formed in the valley of the Nile by the annual inundations of that river; and here it fortunately happens that history comes to the aid of the geologist. These sedimentary deposits have accumulated round the bases of monuments of known age; and we are, therefore, at once furnished with a chronometric scale by which the rate of their formation may be measured. The first of the series of measurements undertaken by Mr. Horner was made with the co-operation of the Egyptian Government, around the obelisk of Heliopolis, a monument built, according to Lepsius, 2300 years B. C. A more extensive series of researches has been since undertaken in the district of Memphis; but Mr. Horner has not yet, I believe, published the results. The problems now to be solved in *Palæontology* are clearly defined in the enunciation of the problem recently proposed by the French Academy of Sciences as one of its prize questions, viz., "to study the laws of distribution of organic beings in the different sedimentary rocks, according to the order of their superposition; to discuss the question of their appearance or disappearance, whether simultaneous or successive; and to determine the nature of the relations which subsist between the existing organic kingdom and its anterior states." The prize was obtained by Prof. Bronn, of Heidelberg; and his Memoir, of which I have only seen an outline, appears to be characterized by views at once sound and comprehensive. The leading result seems to be, that the genera and species of plants and animals, which geology proves to have existed successively on our globe, were created in succession, in adaptation to the existing state of their abode, and not transmuted, or modified, as the theory of Lamark supposes, by the physical influences which surrounded them. — *Address of the President British Association for* 1857.

BAYOUS AND DELTA OF THE MISSISSIPPI.

From a paper recently read before the New York Geographical Society, by Erastus Everett, Esq., of New Orleans, "on the Bayous and Delta of

the Mississippi," we derive the following memoranda respecting a proposed plan for reclaiming a large portion of the Delta for cultivation.

The paper opens by a reference to the several rivers in the old world — the Irrawaddy, the Ganges, the Euphrates and the Tigris in Asia, the Nile in Egypt and the Po and Rhine in Europe — having a formation similar to that of the Mississippi, — similar in the Deltas formed at their mouths and similar in that their waters are higher than the adjacent country. Passing from a brief consideration of these, Mr. Everett comes to the Mississippi, the Delta of which, reckoning the territory between the main river and the Hatchafalaya, or Blackwater River, covers an area of seven thousand square miles. The age of this formation, though remote, probably beyond the creation of man, is geologically of recent date. Its appearance is most remarkable; from the passes of the Balize to the bluffs of the Baton Rouge, where the land rises to a height of from sixty to eighty feet above the river, there is not an eminence to relieve the eye. "There is not a single pebble in all the Delta." In order to attain a proper understanding of the formation of the bayous it should be remembered that the river through the whole delta, instead of being in a valley is upon an eminence. Another element to be taken into consideration is the serpentine course of the river in question. The delta is all of it elevated more or less above the gulf on the south, and the bays and lakes on the east, at the same time being much lower than the river at high water. From this peculiar formation, result two classes of bayous; — the first, such as drain a peninsula or neck of land formed by the bends of the river, and drain the neck of land on which are situated Carrollton, Lafayette and New Orleans. And second, such as run out of the river, like the Lafourche and Plaquemine.

The first of these, as they suspend but little sediment, form but small ridges, and those are limited to their immediate banks. They are very useful as natural drains to the district through which they pass. They receive tributaries, whereas the bayous of the second sort give them out. These latter invariably take their departure from the river at one of its bends, and have numerous branches "so that the Mississippi," says Mr. Everett, "from the head of the delta is a mighty natural apparatus for irrigation. These branches are now for the most part filled up as are indeed the bayous themselves. The filling up of these mouths of the parent stream has caused the most disastrous consequences. They were, while open, so many safety-valves, through which the periodical deluge spent its destructive power. All serious evils to agricultural enterprise might have been prevented by filling up their branches and making dykes or levees in the lowest places."

To re-open all of these bayous is hardly possible, though some of them might be opened with advantage, and would secure the riparian proprietors against the losses and inconveniences consequent upon the annual deluge. The proposition to build levees is open to objection on account of the vast expense, and because if the banks are raised the water will rise also, — for it must have vent. What the limit would be can be learned only by actual experience. On the other hand, were the bayous open, the levees might be much lower than now, and crévasses be yet unknown.

Lower Louisiana, says Mr. Everett, was settled too soon, and consequently the lands brought thus too early under cultivation cannot be reclaimed. Before the settlement of the country, when the river was allowed to inundate the whole delta, it left upon it deposits of alluvium which is now carried down to the mouth, where immense deposits are now formed by eddies produced by the meeting of the waters of the river with those of the gulf. While these deposits encroach at the rate of ten rods annually upon the gulf, large deposits accumulate on the lands where it has not been leveed. This natural process of raising the land not being available in cultivated districts, drainage is suggested as a practicable means of producing the same result. Large as would be the expense, it would prove remunerative.

"When," says Mr. Everett, "we consider that all the available agricultural resources of Lower Louisiana consist of little strips of land, running along the rivers and some of the larger outlet bayous, of an average width of only a mile, or at most a mile and a half, and still that these resources are immense, we cannot forbear asking, What will they be when this strip is extended to the width of eight or ten miles? The present generation may not see it, but the time is not distant. It is vain to expect that this will be done by appropriations from the State. It will be done by private enterprise, for the sake of private advantage. Then will be presented in the great delta of the Mississippi, the spectacle that has long been presented in Holland, where the ocean even, has been forced to retire before the enterprise of man. Then the extensive districts, which are now inhabited only by huge reptiles, will swarm with a happy population.

The geological formation of Lower Louisiana has till recently been an unsolved problem. The boring of an Artesian well in New Orleans has furnished a solution of this problem. The thickness of the several strata perforated has been ascertained, and may be stated approximately as follows: — In penetrating to a depth of 600 feet, five different strata were encountered; first — alluvion, seventy feet; second — dark sand and mud, one hundred feet; third — impervious blue clay, twenty feet; fourth — sand, one hundred and forty-five feet; fifth — impervious clay. This stratum, at the time of the last report which I have seen, was not perforated. The second stratum contained a great abundance of shells and roots, and the fourth contains sufficient water to emit from the tube six gallons per minute.

ON THE SUBSIDENCE OF LAND ON THE SEA COAST OF NEW JERSEY AND LONG ISLAND.

The following is an abstract of a paper on the above subject, read before the A. A. A. S., Montreal meeting, by Prof. G. H. Cook, of New Jersey.

In the course of some geological examinations along the coast of Southern New Jersey, my attention was frequently called to various facts indicating a change in the relative level of the land and water, at some recent period. An attentive examination of these facts has led me to the conclusion, that a gradual subsidence of the land is now in progress throughout the whole length of New Jersey and of Long Island; and from information de-

rived from others I am induced to think that this subsidence may extend along a considerable portion of the Atlantic coast of the United States.

The occurrence of timber in the marshes and water below tide-level is common along our whole Atlantic shore. Almost every person at all familiar with shore life has observed the remains of logs, stumps and roots in such places. Generally, however, they have been looked upon as the remains of trees, torn from their original places of growth by torrents or by the wearing away of the shores, and deposited where they are found by the ordinary action of the water. To any one who examines them carefully it soon becomes evident that they grew upon the spots where they now are. The stumps remain upright; their roots are still fast in the firm loamy ground which underlies the marsh — and their bark and small roots remain attached to them. The localities, too, where they are most abundant, are such as are least liable to be affected by the violent action of the water or of storms. Thus they are by far the most abundant on the low and gently-sloping shores of Long Island, New Jersey, and all the states further south, which are protected from the violent action of the surf by a line of sand beaches, at the same time that the numerous inlets allow free access to the tides. In these protected situations, hundreds and even thousands of acres can be found, in which the bottoms of the marshes and bays are as thickly set with the stumps of trees, as is the ground of any living forest.

The first and chief part of my own observations were made upon the southern part of New Jersey, following the shore of Delaware Bay from its head down to Cape May, and the Atlantic shore from Cape May north to Great Egg Harbor. The examinations have since been continued along the shore to New York City, and thence eastward at several points along the south shore of Long Island.

I may remark that the remains of trees are not equally abundant in all localities, owing partly perhaps to differences of exposure, but more to the difference in durability of the various species of wood. In many places, where oak, gum, and other deciduous trees were known to stand formerly, there are no traces of them now; they have entirely rotted away. On the contrary, the pine and the red and white cedar are almost indestructible. I have seen pine stumps several feet under the marsh, where they have been for an unknown period, which retain the characteristic smell and appearance of the wood almost as perfectly as the fresh-cut specimens. At several places in southern New Jersey an enormous amount of white cedar timber is found buried in the salt marshes, sound and fit for use, and a considerable business is carried on in mining this timber and splitting it into shingles for market. In some places it is found so near the surface that fragments of the roots and branches are seen projecting above the marsh, while in other cases, the whole is covered with smooth meadow sods, and there is no indication of what is beneath till it is sounded by thrusting a rod down into the mud.

It is in deposits where these durable species of wood are found that we get the most accurate idea of the depth to which these remains extend. At Dennisville, there is a large tract of marsh underlaid by cedar swamp earth and timber. By probing the marsh with an iron rod the workmen find

where the solid timber lies, and then, removing the surface, sods and roots, they manage to work in the mud and water with long one-handled saws, and cut off the logs, which, as soon as they are loosened, rise and float, and of course are easily managed. The timber is not water-logged at all, but retains its buoyancy, and the removal of that nearest the surface releases that which is below, and it rises, so that a new supply is constantly coming up to the workman. In this way a single piece of swamp which is below tide-level has been worked for fifty years past, and still gives profitable returns. The timber is found lying in every direction, some appearing to have been blown down by the wind, and some appearing to have died and fallen after it was partially decayed. The fallen timber has been covered by the accumulation of muck from the decayed leaves and twigs, and other timber has grown on this, to fall and in its turn give place to still another growth. How long this accumulation has been going on it is impossible to tell. Dr. Beesley, of Dennisville, counted 1080 rings of annual growth in a stump, and lying directly under this, so that it must have fallen before this grew, was a log with 500 rings. I have seen them lying in this way, log under log, indicating that thousands of years must have passed while they were accumulating. And this is only the superficial portion of it.

Instances of submerged trees are not confined to the coast of New Jersey, but they occur along the whole coast of the Atlantic States, from the Bay of Fundy to Florida.

There is another class of facts somewhat similar to those above-mentioned, and of common occurrence along our shores, from which these should be distinguished. The facts to which I refer are such as the following. At Cape Island, Cape May county, there are found stumps of oak trees at tide level which have been covered by twelve or fourteen feet of upland soil — cultivated farm land — and have but recently been exposed by the wearing away of the shores. At Union, on Raritan Bay, in solid earth and about two feet below low water, common hard-wood stumps were found, in digging a large basin. Upright stumps of trees have also been found in digging wells on the upland, at numerous places near tide water, on Delaware Bay and the Atlantic shores. In similar localities, shells of the common clam, oyster, and other recent species have been found in wells, and I have observed them at various places several feet above high tide.

In the bank of Maurice River, seven or eight feet above high water, and still covered by several feet of sandy earth, is an oyster bed. It is exposed for some rods. The shells are in common blue mud, closely wedged in together, and standing with the opening of the valves upwards, just as in the living beds. At Tuckahoe, casts and impressions of the common clam are found in the gravel at eight or ten feet above high water. And at Port Elizabeth, and near Leesburgh, shells of the clam and oyster, and indeed of nearly all the species of shells now common in the bay are found, covered by from two to six feet of sandy loam, and are extensively dug for manure. I was lately informed of the existence of an oyster bed under similar circumstances on the beach a little north of Long Branch. Deposits of recent shells are found in much the same way, on all our Atlantic coast, and also on the

Gulf of Mexico. So many accounts have been given by different observers, that for the present purpose it is not necessary to specify them. Attention is called to them now as indications of a period of subsidence, and then one of elevation preceding the present.

The fossils, it will be perceived, are in circumstances which require that the ground should have occupied a much more relative level than the present, and the covering which is over them is upland soil, — portions of that in New Jersey are in cultivation, — and are among the most valuable and productive soils in the state. While, on the contrary, the remains of trees, etc., which are specially referred to in this paper are all as low as the present level of high tide, and are covered only by water, or by marsh mud, and roots. They are also of a much more recent date, some of them having been growing trees within the memory of persons now living, and the subsidence which has produced them is one that is still in progress, as I wish now to show.

All along the Delaware Bay there is a salt marsh, from a mile to five miles back, and back of it the land is low and almost level. At a point near Salem, a portion of what is now salt marsh was, within the memory of man, a maple grove on this upland, and an island in the middle of it is still so. In another place, land which has been cultivated is now salt marsh. In another place, land is salt marsh which is mapped in the earlier maps as timber; an owner of an extensive tract there, told me he had lost at least 1,000 acres of timber land by the advance of the tide upon it. This advance is marked every year by its cutting off a small fringe of the timber which dies, and the process seems to go on more and more rapidly — and the timber which is killed is never replaced by timber, but by salt marsh. I found old men who had seen timber growing where now it was marsh, and in some places I found long rows of the red cedar standing in the marsh, a foot deep or more in the mud of the marsh.

The lower part of New Jersey is exceedingly favorable for observations of this character, from its being so flat that on a railroad line, running through Cape May County, the highest point was not more than twenty-eight feet above high water, and the average but eleven feet. On such shores it will readily be perceived that a very slight depression of the surface must bring a broad strip of land under water, and that marks of such depression will be found in much greater abundance than in localities where the shores are bolder.

The people along the shore of such places are very sensible of this change of level between land and water, and are perfectly well satisfied that the remains of the timber found are in the places where they grew, and that they have not gone down by the ground washing away, or becoming more compact. When it was objected to them that the white cedar trees have no tap roots, but grow directly upon the muck, and, of course, that they might have settled; it was readily admitted that one might think so, but for the fact that when the cedar grows so that its roots can reach hard ground as they can when the swamp is shallow, that then the timber is worthless on account of the fibres interlocking so that it cannot be split into shingles, and that in

shallow swamps, and in the bottoms of the deeper swamps, such timber is found, which is to them a plain evidence that it grew there. Further, they find at the bottom of such swamps gum and magnolia trees which have grown upon the hard ground. Pine stumps are also found at considerable depths below the surface; these are tap-rooted, and their roots reach the solid ground so that they are not liable to settle. It is the general impression, however, that the cedar swamps do not settle as long as they remain constantly wet.

After examining all I have been able to find written upon the subject, and after studying it in the field, I can think of no other theory which will apply to all the facts, except that of a slow and continued subsidence of the land.

The rapid wear of the shores may fairly be adduced as confirming my conclusions in regard to subsidence. A few cases of this rapid wear may be given. Egg Island, a point well known to those who are familiar with Delaware Bay, is put down on the first map, made by the proprietors of West Jersey, in 1694, as containing three hundred acres of land. It now contains only about three-fourths of an acre at low water, and high tides cover it entirely. Capt. J. W. Herbert, a very intelligent wreck master, at Keyport, has a number of marks on the beaches to determine the location of sunken vessels, and from these he is able to measure the wear from year to year, and the average which he deduces from these is not less than twelve feet a year along the whole shore. On Long Island the wear of the beaches is not so uniform, but is perceptible. On the east end of the Island the wear is very great, and has attracted attention ever since the first settlement of the country.

As to the rapidity with which this subsidence is going on, we have no very certain data. There are some stumps of trees, probably cut within the last 150 years, which are now run over by high tide, so that the person who pointed them out to me was confident that there must have been a change of three feet in the tide. At a milldam one person was confident that the tides rose higher than they did twenty years ago, though how much he could not tell, for a mark which he had made had become obliterated. At another place a miller told me he could not run his mill as long as he used to be able to, because the tide backed up against his wheel. He thought he had lost eight inches in twenty-five years. At another mill the tide rose some twelve or fifteen inches higher, and its wood-work and foundation were placed on the solid upland. Another mill, built 100 years ago, has lost so much that the tides come up half way on the dam, and they can only run that mill by having built another dam below it to keep out the tide.

Another mill had been watched for twenty-five years, and my informant was confident it had lost four inches, and, he thought, more.

From these facts we may set down the subsidence at, perhaps, two feet in a century.

With the exception of the statements of two pilots, upon the Raritan River, I have nothing upon which to base any estimates for the present rate of subsidence in the vicinity of New York. One of the pilots founds his conclusion upon observations made upon the wharf at Washington, and is confident

there is eight inches more of water there than there was twenty-five years ago. The other draws his conclusion from the depth of water upon the reef of rocks in the river below New Brunswick, and the depth upon the middle ground near Amboy, and from the action of the centre-board of the vessel which always touches at these points, he is satisfied that the water is deeper than it was thirty years since; but he thinks not six inches deeper. The opportunities for accurate observation are much less frequent here than in the southern part of New Jersy, but from the phenomena of the marshes and of the submerged forests on Long Island and in nothern New Jersey, I should infer that there was no material difference in the rate from that already deduced.

ON THE EXISTENCE OF FORCES CAPABLE OF CHANGING THE SEA-LEVEL DURING DIFFERENT GEOLOGICAL EPOCHS.

If, in assuming its present state from an anterior condition of entire fluidity, the matter composing the crust of the earth underwent no change of volume, the direction of gravity at the earth's surface would remain unchanged, and consequently the general figure of the liquid coating of our planet. If, on the contrary, as we have reason to believe, a change of volume should accompany the change of state of the materials of the earth from fluidity to solidity, the mean depth of the ocean would undergo gradual, though small changes over its entire extent at successive geological epochs. This result is easily deduced from the general views contained in other writings of the author, whence it appears, that if the surface stratum of the internal fluid nucleus of the earth should contract when passing to the solid state, a tendency would exist to increase the ellipticity of the liquid covering of the outer surface of the crust. A very small change of ellipticity would suffice to lay bare or submerge extensive tracts of the globe. If, for example, the mean ellipticity of the ocean increased from one three hundredth to one two hundred and ninety-ninth, the level of the sea would be raised at the equator by about 228 feet, while under the parallel of fifty-two degrees it would be depressed by 196 feet. Shallow seas and banks in the latitudes of the British Isles, and between them and the pole, would thus be converted into dry land, while low-lying plains and islands near the equator would be submerged. If similar phenomena occurred during early periods of geological history, they would manifestly influence the distribution of land and water during these periods, and with such a direction of the forces as that referred to, they would tend to increase the proportion of land in the polar and temperate regions of the earth, as compared with the equatorial regions during successive geological epochs. Such maps as those published by Sir Charles Lyell on the distribution of land and water in Europe during the tertiary period, and those of M. Elie de Beaumont, contained in Beudant's "Geology," would, if sufficiently extended, assist in verifying or disproving these views.—*Professor Hennessy. Proc. British Association, Dublin.*

ON THE SILURIAN SYSTEM.

At a recent meeting of the Geological Society, London, Sir R. I. Murcheson, in a paper on the Silurian rocks of Scandinavia and Russia, took occasion to point out the extent of the great northern Silurian basin. Beginning with the comparatively small fragments of this great deposit in the British Isles, the Silurian rocks may be traced across the main land of Sweden, through the islands of Oland and Gothland, to the southern shores of the Gulf of Finland. Here they extend through the province of Esthovia, south of Revel and Narva, towards St. Petersburg. From the government of St. Petersburg, the range taking a direction from W.S.W. to E.N.E., is lost beneath the vast deposits of Lakes Ladoga and Onega. It re-appears, however, on the flanks of the great Ural chain, and traversing Siberia, is again found in North America, covering a vast extent of Canada, occupying in detached masses more than a thousand miles in width from Canada to the state of Alabama, and extending westward from New York to the furthest western prairies.

With reference to the European portion of this great Silurian area, the northern basin of the British Isles, Scandinavia, and Russia, appears to be separated by marked paleontological characters from the Silurian rocks of Southern Europe, as they exist in France, Spain, and Bohemia. In limited areas, such as that of the British Isles, the evidence derived from fossil remains was much more restricted than where larger areas were examined. For instance, throughout the whole range of the British Silurian rocks, definite species of mollusca, crustacea, and corals, were found to characterize certain beds, but when the whole northern area of the Silurian rocks is examined, these species are found to range upwards and downwards into other beds, and thus the whole formation is much more converted into one unbroken series than would be justified from the examination of the British Isles alone. Sir Roderick quoted many examples of upper and middle Silurian fossils occurring very low down in the rocks of Scandinavia, and thus supported his views so often and so long ago expressed that one unbroken chain of life extended from the top of the Silurian series down to the base of the Llandeilo flags and Lingula beds. He held it, therefore, impossible to draw any line of separation between the Silurian rocks and those which had been called Cambrian, unless that line be drawn at the base of the Lingula flags.

HEIGHT OF NORTH CAROLINA MOUNTAINS.

The lofty peaks of western North Carolina were barometrically measured by Prof. Guyot, in July, 1856, with the following results. These twelve summits are all higher than Mount Washington in New Hampshire, which, according to Professor Bache's survey, in 6,285 feet in height.

1. Clingman's Peak, 6,701 feet; 2. Guyot's Peak (or Balsam Cone), 6,661 feet; 3. Sandoz Knob, 6,612 feet; 4. Hairy Bear, 6,597 feet; 5. Cat-tail Peak, 6,595 feet; 6. Gibbe's Peak, 6,586 feet; 7. Mitchell's Peak, 6,576

feet; 8. Sugar-Loaf (or Hallback Peak), 6,401 feet; 9. Potatoe Top, 6,389 feet; 10. Black Knob, 6,377 feet; 11, Bowler's Pyramid, 6,345 feet; 12. Roan Mountain, 6,318 feet.

THE HORIZONTAL HEAVE OF ROCKS.

At a recent meeting of the Boston Society of Natural History, Prof. Wm. B. Rogers made some remarks upon a peculiar geological condition which he had noticed in the Slate Rocks of Governor's Island in Boston harbor, and of which he had never seen any notice. At the landing near the fort, where the slate is exposed, he had observed a series of ledges of dark grayish-blue slate, in which is exposed a species of *fault* known as *horizontal heave.* There are two lines of direction in the beds, and these are at right angles with each other. This phenomenon of horizontal heave, combined with the system of cross cleavage which is at right angles with the planes of bedding, creates some obscurity in some spots as to which are the original planes of bedding. In other localities, especially in the Quincy and Braintree silicious slate in which trilobites have been recently found, the same difficulty exists; rendering it impracticable to obtain perfect specimens of that fossil in any amount, since the rock splits off in an opposite direction to that in which the animal was deposited.

This system of horizontal heave has been extensively studied in Europe, and has elicited much discussion from geologists and physicists upon the theory of the phenomena engaged in its production. It is supposed that a great pressure has been applied to the rocky mass, either before or after it had reached a complete state of solidity, and that this pressure has produced such a structural arrangement as to develop particular planes of cleavage where the adhesion was the slightest. This supposition has been sustained by experiment, recently instituted in England, in which it has been demonstrated that scales of mica and other material of flattened form, intermingled with plastic clay and submitted to continuous and energetic pressure, assume approximate parallelism, and impart to the mass a laminar structure. Where cleavage shows itself in limestone containing mica scales and flattened particles of silica, the microscope has detected an approximate degree of parallelism between these substances and the cleavage planes.

ON THE LAKES OF EASTERN ASIA.

At a recent meeting of the London Geological Society, Mr. Loftus read a paper on "An Analysis of the Water in several of the great lakes at the base of Mount Ararat, and the Mountain Chains of the Kurdistan between Turkey and Persia." The water of Lake Vann and the others he described as remarkable for containing immense quantities of salts, chiefly those of soda, as the carbonate of soda, the sulphate of soda, together with chloride of sodium (common salt). It was supposed that the springs which feed these lakes dissolve large quantities of soda and potash out of the volcanic rocks with which they came in contact and deposit these salts in the lakes. As the water evaporates the strength of the solution increases, year by year,

and becomes at length so strong as to crystallize when evaporated to a sufficient extent. It appears the salts contained in these lake waters are used in the neighborhood for the manufacture of soap, and Mr. Loftus is of opinion if it were not for the great expense of transport they might be profitably brought to England, where there are many important uses for these various salts of soda.

At present the material would have to be taken by land carriage over seventy miles of sandy country, destitute of roads, in order to reach the Caspian Sea, and this operates as a complete bar to any commercial speculation in the matter.

THE THEORY OF GLACIERS.

The interesting phenomena presented by the glaciers of the Alps have of late occupied much attention among scientific men. One chief point of difficulty is, to account for the existence, in the white porous mass of the glacier, of laminæ, or streaks of blue ice, of superior density to the rest. Professor James Forbes of Edinburgh has offered a theory to account for this appearance, which has been hitherto generally accepted in the scientific world. He supposes that ice is in a viscous, or, as he sometimes expresses it, a semi-fluid state when in motion. The friction at the sides of the glacier prevents its lateral portions from moving with the same velocity as the central. Fissures are supposed to be formed in consequence of this differential motion. The drainage water from the surface is next supposed to flow into these fissures, to become frozen there, and thus to form the blue laminæ. The explanation of the directions in which the laminæ run in different parts of the glacier is founded upon known laws of motion into which it is needless for us now to enter.

In a lecture delivered at the Royal Institution, and in a paper read at the Royal Society, Professor Tyndall, in conjunction with Professor Huxley, has advanced a new theory. The idea that ice is viscous, he regards as a conjecture opposed to common experience. The supposition that the blue veins are formed by the drainage water, he rejects, and refers the lamination of the glacier to the same general principle, which he has already proved to be the cause of the lamination of slate rocks. This principle he illustrates by pounding a common slate into an impalpable powder, mixing it with water, and then subjecting it to pressure. It splits at right angles to the line of pressure, just like the original slate from which it has been formed.

Professor Tyndall tried the same experiment on snow. A quantity of the substance subjected to pressure exhibited on a small scale the structure of the glacier.

The closing up of crevasses, and the establishment of the continuity of the glacier after it has been broken into fragments in descending precipitous slopes, are accounted for by reference to a principle for which the term "regelation" has been suggested by Dr. Hooker. It is found that fragments of ice, placed in contact in a hot sun, and even under boiling water, become re-united, or frozen together. This fact, as Dr. Tyndall asserts, sufficiently

accounts for the continuity of the mass of the glacier, without supposing, with Professor Forbes, that ice is of a viscous or plastic nature.

Professor Tyndall has illustrated the laminæ, or cleavable nature of ice, by many beautiful experiments. In one case, he succeeded in impressing, upon a transparent prism of ice, a lamination which might be mistaken for that of gypsum.

By means of a small hydraulic press, he converts spheres of ice into flat cakes and transparent lenses — a straight prism of ice six inches long is passed through a series of moulds augmenting in curvature, and finally comes out bent into a semi-ring. A piece of ice is placed in a hemispherical cavity, and is pressed upon by a protuberance not large enough to fill the cavity, and is thus squeezed into a cup. In short, every observation made upon glaciers, and adduced by writers upon the subject in proof of the plasticity of ice, is shown to be capable of perfect imitation with hand specimens in the laboratory. These experiments demonstrate a capacity on the part of small masses of ice hitherto denied to them by writers upon this subject. They prove to all appearance that the substance is even more plastic than it has hitherto been supposed to be.

ASCENT OF CHIMBORAZO.

The summit of the Chimborazo has lately been found to be quite ascendable. When Baron Humboldt, with his friend Bonpland, on the 23d of June, 1802, meant to ascend the Chimborazo, which at that time was considered to be the highest mountain on earth, he had to turn back at the height of 5,909 mètres, an insurmountable wall of rock barring his advance. Boussingault, the second who attempted the ascent, arrived, on the 16th of December, 1831, only up to 6,004 mètres, — ninety-five mètres higher than Humboldt. A late number of the *Journal des Debats* publishes a letter from the French traveller, M. Jules Rémy, who, in company with an English traveller, Mr. Brenchley, ascended the mountain from a different side, on the 3d of November, 1856; and, although wrapped in entirely by thick veils of clouds, and forced by a violent storm to return, yet attained the height of 6,543 mètres (according to Humboldt's trigonometrical survey, the height of the mountain is 6,544 mètres), where the travellers lit a fire. It is questionable if M. Rémy reached the absolute top of the mountain, but no doubt is now left that this can be accomplished. The column of air at that height was still quite sufficient for breathing. The shortness of breath and the other symptoms usually noticed on reaching such heights have been perceived neither by M. Rémy nor by his English companion, as the former expressly states.

ON THE DENSITY AND MASS OF COMETS.

BY M. BABINET.

All astronomers are agreed that the mass and density of comets are very small, and that their attraction cannot produce any sensible effect upon the

movements of the planetary bodies. We shall see that from the effects observed, combined with the law of optics, we may deduce the conclusion, that the direct shock of one of these bodies could not cause the penetration of the infinitely rarefied matter of which they are composed, even into our atmosphere.

It is a well ascertained fact, that stars of the tenth and eleventh magnitude, and even lower ones, have been seen through the central part of comets, without any sensible loss of brilliancy. Amongst the observers who have frequently proved this optical fact, we find the names of Herschel, Piazzi, Bessel and Struvé. In most instances, says Mr. Hind, there is not the least perceptible diminution in the brilliancy of the star.

I shall take as an example the well known comet of Encke, which is sometimes visible to the naked eye, and generally presents a rounded mass. In 1828, it formed a regular globe of about 500,000 kilometres in diameter, with no distinct nucleus; and Struvé saw a star of the eleventh magnitude through its central part, without noticing a diminution of brilliancy. In an observation of M. Valz, on the other hand, a star of the seventh magnitude almost entirely effaced the brightness of a brilliant comet. Let us start from these observed facts.

Since the interposition of a comet, illuminated by the sun, does not sensibly weaken the light of a star in front of which it forms a luminous current, it follows that the brilliancy of the comet is not a sixtieth part of that of the star, for otherwise the interposition of a light equal to a sixtieth part of that of the star, would have been sensible. We may, therefore, assume, that at the utmost the brilliancy of the comet equalled a sixtieth part of the light of the star. Thus, by this hypothesis, if the comet were rendered sixty times more luminous, it would have a lustre equal to that of the star; and if it had been rendered sixty times sixty times, that is to say, 3600 times more luminous than it was, it would then have been sixty times more luminous than the star, and in its turn would have made the latter disappear by the superiority of its lustre.

The conclusion from this is, that it would have been necessary to illumine the cometary substance more than 3600 times more than it was illumined by the sun, to enable it to cause the disappearance of a star of the eleventh magnitude.

We may assume that the light of the moon causes the disappearance of all the stars below the fourth magnitude; thus the atmosphere illumined by the full moon acquires sufficient luminosity to render stars of the fifth and all lower magnitudes invisible. Between the fifth and the eleventh magnitudes there are six orders of magnitude, and according to the fractional relations of these different orders we may admit that a star which is a single degree of magnitude above another, is two and a half times more luminous than the latter. A star of the fifth magnitude is 250 times more brilliant than a star of the eleventh magnitude. Thus the illumination of the atmosphere by the moon is much more intense than the illumination of the cometary substance by the sun itself, since it would be necessary to render the comet 3600 times more luminous to enable it to extinguish a star of the

eleventh magnitude, whilst the luminosity of the atmosphere illuminated only by the moon is sufficient to render invisible, stars which are 250 times more brilliant.

The disproportion becomes still more striking when we consider, that according to the measurements of Wollaston, to which Sir John Herschel says he sees no objections to be made, the illumination of the full moon is a little less than the eight hundred thousandth part of the full illumination of the sun.

To complete the data of our definite calculation, we shall call to mind, that, according to the density of the air in the lower strata of the atmosphere and its total weight, as indicated by the barometric column, the whole stratum of air which constitutes the atmosphere is equivalent to a stratum of about eight kilometres in thickness, and possessing the density of the air at the surface of the earth.

We have already found that it would be necessary to render the comet 3600 times more luminous for it to extinguish the lustre of a star of the eleventh magnitude. To render a star of the fifth magnitude invisible it would require to be made 3600 + 250 times more brilliant than it is. In other words, if the atmosphere were 3600 + 250 times less compact than it is, it would be equivalent to the comet. As 3600 + 250 make 900,000, the nine hundred thousandth part of the atmosphere would suffice to produce the same effect of illumination as the comet; but as the latter is in the full light of the sun, while the atmosphere is only illuminated by the moon, when it extinguishes stars of the fifth magnitude; this circumstance gives the atmosphere a further advantage in the proportion of 800,000 to 1, which under ordinary circumstances gives the atmosphere a superiority equal to 900,000 + 800,000, or 720 billions. But this is not all; the thickness of the cometary substance being 500,000 kilometres, whilst that of the atmosphere is only eight kilometres; we must increase the above relation in the proportion of 500,000 to 8, which brings it to forty-five millions of billions, thus— 45,000,000,000,000,000.

Thus, according to these data, the density of the substance of a comet could not be calculated at so high a quantity as that of the atmosphere, diminished by the enormous divisor, forty-five millions of billions. The shock of a substance so rarefied would be nothing at all, and not the least particle of it could penetrate even into the most rarefied parts of our atmosphere.

According to experiments of my own, gases lose their property of elasticity long before they are reduced to such low density. I do not think that at the ordinary pressure a gas could completely fill a vessel with 20,000 times the original volume of the gas. The substance of comets is, therefore, a kind of very divided matter, with its molecules isolated and destitute of mutual elastic reaction.

It follows from the preceding that both the mass and the density of a comet are infinitely small, and without any hypothesis we may say that a sheet of common air of one millimetre in thickness, if transported into the region of a comet, and illuminated by the sun, would be far more brilliant than the comet.

The mass of the earth, according to the calculation of Baily, may be reckoned at 6,000,000,000,000,000,000,000,000 kilogrammes.

The matter of comets being assimilated above the air, of which the density would be 45,000,000,000,000,000 times less than that of the ordinary air, this would lead us to assimilate it to the substance of the earth diminished to about 194,000,000,000,000,000,000,000 times less than its ordinary density. By this estimate, a comet as large as the earth would only weigh 30,000 kilogrammes; this makes thirty tons of 1000 kilogrammes, or the weight of thirty cubic metres of water. — *Comptes Rendus*, 1857. *Feb.*

In a subsequent paper presented to the Academie in May, 1857, M. Babinet enters into a calculation to ascertain the mass and density of the great comet of 1825, which did not diminish the light of a star of the fifth magnitude seen through the centre of the comet, to the amount of one-fifth. His conclusion, founded on the diminution which light undergoes in passing through air of known rarety, is that the substance of the comet of 1825 possessed a density, which compared with atmospheric air at the surface of the earth, must be indicated by a fraction, having unity of its numerator, and for its denominator a number superior to unity, followed by one hundred and twenty-five ciphers.

When Herschel, in his last work on astronomy, spoke of a few ounces as the mass of the tail of a comet, he found nearly as many disbelievers as readers. Nevertheless, says M. Babinet, his calculation is exaggerated in comparison with the preceding determination. M. Babinet promises, in a future paper, to take up the very suggestive question, "How are comets visible?"

CENTRAL RELATIONS OF THE SUN AND EARTH.

BY C. F. WINSLOW, M. D.

In analyzing a record of 850 earthquakes and volcanic eruptions, collected from all sources, the monthly tables read as follows: For

April,	50	October,	95
May,	47	November,	95
June,	44	December,	102
July,	55	January,	94
August,	64	February,	75
September,	64	March,	65
	324		526

By a glance at the above summary, it will be seen that the *greatest number* of these events have occurred during the course of the planet through the *perihelic sections* of its orbit; that they increase steadily till the earth reaches the perihelion; and then diminish, until *at aphelion they are fewest.* In this respect these phenomena show a very steady and close inverse reference to the length and sweep of the radius vector; and from this point of view, holding unmistakable connection with well-known astronomical laws, they become special results of solar causes. *How do these causes operate?*

One of the most remarkable facts in Robert Mallet's Report of 1851, to

the British Association, was, that more earthquakes occurred in *our* "winter months" than in the other months of the year. My facts accord with his in this particular.

Von Tschudi ascertained, by his inquiries in Peru, that an excess of earthquakes occurred in that country in November, December and January of each year.

By the most careful and extensive search into the observations of natives and foreign residents, during a fortnight spent at Acapulco, in Mexico, in 1853, I discovered that the same preponderance of earthquakes, both as to number and violence, prevailed there from October to February every year.

Since that time I have found the same notable fact to exist at Hawaii, although perhaps less marked as a regular annual result, in consequence of the plutonic outlet of Kilauea being constantly open, and more or less active. Nevertheless, of eighty-nine earthquakes observed at Hilo in twenty-two and a half years, *seventeen* more occurred during the six perihelic months, than during the aphelic months. This is deduced from the record of Mrs. Lyman, the missionary at Hilo, furnished to me by Rev. Titus Coan, of the same place.

An intelligent observer, John W. Widdifield, of New York City, who resided at Petropaulaski, Kamtschatka, for one and a half years, informed me that it was a *fact well known* to the Russian residents, and that he had observed the same, that earthquakes, which are frequent there, occur in greater numbers in the winter than summer, and that a volcano in sight of his residence was more active in the winter than summer.

Mons. Victor Prevost resided for two years at the Isle of Bourbon, nearly the antipode of the last-named locality, about the same time that Mr. Widdifield resided in Kamtschatka, and he became familiar with the phenomena of the famous volcano on that island. He stated to me, as the common observation of the inhabitants, and of his own knowledge, that the crater is quiet for six months, and active for six months; and that every year the lava flows from it in December and January.

It is also given as a well-observed fact that earthquakes are more frequent in Chili from October to March, than at the other period of the year.

Dolamieu, Hamilton and Scrope long ago stated, on the authority of the inhabitants of the Lipari Isles, that the eruptions of Stromboli were far more violent during "the *winter seasons* than in summer."

Here is a great array of authentic and suggestive facts which cannot be controverted, but which must increase every year, all tending to one point, and that is, that *plutonic agitations of the globe hold a permanent inverse ratio to the length of the radius vector*; that is, *the distance of the centre of the planet from the centre of the sun.*

All evidence tends to this conclusion, that the sun is the PRIME *genetic agent* of earthquakes and of every other pluto-dynamic impulse which acts against the crust of the planet, and breaks or elevates any of its parts.

The question now arises as to the nature and operation of the SOLAR GENETIC AGENCY, by which results so stupendous and regular, are produced

from the centre of the planet outwardly in all radial directions, since it is so isolated in space and so remote from the central body of our system.

Earthquakes, emissions of lava from orifices in the globe, and the formation of islands and continents, are all minima or maxima *sequences* of one and the same SYSTEM of cosmical dynamics. This consists in the elastic movements of plutonic matter — the *repelling action of particles* — from the centre of gravity in all directions upon the crust of the globe. These phenomena do not result from mere solar attraction as commonly understood and taught as operating on the nearest matter presented in the planetary mass, and thus drawing it away from that more remote, inasmuch as this operation would relieve the crust from the pressure of molten matter, or any other sort of matter beyond it, and prevent what Newton's theory of tides, as taught, might at first thought make probable. They cannot either depend on the light or heat of the sun, because earthquakes occur with as great force and frequency in the night, when the ruptured point of the planet is most remote from the sun, as when it is under the sun's meridian. Besides, it is well known that solar heat only penetrates the earth a few feet, and that it does not affect the bottoms of oceans at all, while earthquakes and volcanic eruptions frequently take place in all oceans, and also in high northern and southern latitudes.

All discussions of this subject tend to carry me further and further from the acceptance of any physical theory now received among philosophers.

Gravitation itself does not indeed become a questionable fact in my considerations, but when applied alone to the inquiry into the nature of these phenomena it fails to explain them. They demonstrate the expression of a force whose dynamical sequences declare the reverse of gravitation, although the present relations of matter were primarily brought about by, and do in reality exist through the agency of this force.

A careful review of the subject shows that, while solar attraction is inversely as the square of the earth's distance, and while the planet, throughout its mass and volume, moves in space as if it were a *unit* or *mere point* in obedience to this law, *the individual particles of the planet are, in like manner and in reality, held to its centre by an attraction which follows the same law.* This gravitation of individual particles, all aggregating in radial lines from the outmost bounds of the atmosphere to the centre of the sphere, constitutes the earth's density. It then follows that the earth is subject to the same law which we know to reign over the density of comets and planets; that is, the nearer the sun the greater the intensity of attraction between its individual particles, and the stronger the attractions of these to the centre of gravity; in other words, *the greater its density,* — not the greater attraction of one side away from the centre, and still more from its antipode, — *but the greater the attraction in both these points at the same moment to the centre of gravity.*

Now, as the earth's density depends on the gravitating power of its individual particles to its centre, *which centralizing force varies inversely with the earth's distance from the sun,* or, in more exact words, is inversely as the square of the radius vector, we discover vast and unexplored fields of inquiry open to research respecting the daily changes and developments of force

among the particles of the sphere, the movements and directions of these currents of force, and the dynamical motions of molten matter from the centre to the surface of the globe.

This step in my researches connects astronomy with geology, discloses the cause of terrestrial magnetism, binding it with all minor experimental inquiries and with the observations and discussions of all facts collected throughout the surface of the planet, and even explains its connection with the Solar Spots, inasmuch as no agitation can take place in the sun without coincident changes in its molecular forces affecting its density, or the physical relations of its particles, which changes are immediately felt in our own globe, through *the connection of its centre with the forces of the solar centre.* Thus too, this research brings us face to face with the prime cause of all physico-plutonic phenomena, not only that of earthquakes and volcanoes, but of those displays of dynamical power exhibited in the elevations of mountain ranges, and in the formation and revolutions of continents. Earthquakes and plutonic eruptions, being events which maintain particular relations to time, and being results of graduated operations of force on matter, become objects of new and intense interest.

Their explanation becomes indeed simple when we recognize the fact that all great dynamical disturbances are only effects of the accumulated forces of particles. The *individual properties and principles of molecules,* inertia, attraction and repulsion, being recognized, it is safe to follow both matter and force wherever their combinations and expressions may lead us. Consequently, as the *attractive forces* accompany *atoms* into their cosmical combinations and constitute the great centralizing force of gravitation, so the repulsive forces must follow the same atoms (*for they cannot be lost*) and constitute another active power *within* the globes throughout space, — a power whose dynamical energies *within our own planet* as elsewhere, have hitherto been wholly ignored. The alternating exertions of these two forces have been plainly enough exhibited in the motions of the matter constituting the translucent spheres of comets, in their regular contraction and expansion, as they approach and pass away from the sun. The fact, as a mere statement, is noted by all telescopists; but its physical importance has been overlooked, and no explanation of the phenomenon has ever been attempted. Inertia, a given impulse, and gravitation may be sufficient in the formulæ of mathematicians to account for the motions of the heavenly bodies. That point is not here called in question; but the force of gravitation alone is not sufficient to account for phenomena which are of daily occurrence *within the boundaries* of the spheres that compose this solar system.

Following the two forces of attraction and repulsion with metaphysical pertinacity into the material constitution of cosmical bodies, we discover the same law to prevail in nature which is exhibited in all our experiments with matter.

Disturb the equilibrium of molecular status in any form of matter by impact, pressure, or by any motion, and the repulsive force is instantly awakened, however long it may have remained dormant. Thus originates a palpable material tension, — the representative of molecular repulsion, which

in its most magnified expression, represents *within the boundaries of a sphere,* a FORCE *the* REVERSE *of gravitation.* Immediately following the change of relations between these two fundamental forces there spring up new forms of force, as electricity, light, heat, and magnetism with *their* opposites. All are generated from the same sources. Each may become insensibly converted into the other, and all vanish back again into the original essential properties of molecules from which they sprang. All the conditions of these dual principles obey in exact ratios, the laws which govern their fundamental molecular congeners: and their amounts correspond with the degree of motion, condensation and vibration between atoms, and are developed on a scale as vast as the volume or capacity of the body submitted to external action, and corresponding internal and central excitation. The density of the earth *at its aphelion* is such that constant tension exists, yet, both density and tension become greater when the planet is nearest to the sun. Thus, notwithstanding a steady repulsive energy or molecular tension is exerted *during all time,* from the centre of the earth, in all radial directions upon its crust, (as a sequence of solar force,) so that fractures of its crust producing earthquakes or molten eruptions, would inevitably often occur when the globe is in aphelion; still as the intensities of force between the atoms change by fixed central laws, with *every point of time* during which a sphere moves in space, the representative power of molecular repulsion increases from the centre to the surface in direct proportion to the planet's density, and *attains its maximum as an earthquake and plutonic force when this density is the greatest.* This state of things takes place at perihelion.

A word of illustration may render the above statements more lucid. A mass of matter, free at the surface of the globe from palpable tension, if carried toward its centre, would have its particles excited or impelled into closer juxtaposition, during which condition repulsive energy, as above defined, would increase in proportion to its density. Similar developments of dynamic energy would accompany this translation of matter from the surface toward the centre, as are sensibly displayed by a solid ball of India rubber when compressed. Indeed the same physical results would follow; for even India rubber or any other substance subjected to fluctuating impact, or vibratory disturbance of its molecular forces, generates heat, magnetism, electricity or light. *These two forces developed and fluctuating in intensity in radial lines, from centre to surface,* become planetary fountains of power producing not only dynamic disturbances, as earthquakes, volcanoes, elevations of land and swellings of the seas, but those imponderable principles of heat, magnetism, and electricity whose currents freely pass within and without the globe. From the preceding points of view, it will be seen that the solar forces acting upon the planet in an inverse ratio of the square of the radius vector, are not mere incidental and wasting elements, but *absolute creative effluences* which enter into the *mundane centre* and become a sort of physical animus to the sphere, producing the *cohesion* of every atom with every other atom, transfusing into each and all, their very laws and ratios of power; and, by regulating their individual intensities of attraction and repulsion, modify the density of the globe, and become transformed in its bowels into

heat, in the solid crust into magnetism, in the ocean and air into electricity and light, each new expression of force being but the equivalent of the other, and all in turn *contributing to the genesis and continuance of organic forms* which again returning to the earth, yield up their forces to enter into the constitution of senseless shapes through unending cycles. In this inquiry the imperceptible effluences of the solar centre assume visible functions, and an importance in terrestrial changes and in organic creations, which have never heretofore been detected.

Thus the discovery that all plutonic phenomena spring from the fluctuating play of central forces between the sun and earth, which as molecular aggregates correspond in their mutual relations with known fundamental atomic laws, and which also as cosmical and dynamic functions bear constant inverse ratios to the length of the radius vector, connects the first great physical truth discovered by Copernicus, with that sublime conception recently announced by Faraday, respecting the probable identity and conservation of all force.

In this sketch all astronomical discussions are omitted. But that the same facts occur in the sun itself, there can be no doubt, inasmuch as the agitations of its envelops show the same distributions and transitions of the molecular forces, observable on the earth; and the volcanoes of the moon, and the inequalities of the other planets show a fluctuating play of the same forces to have taken place within them, acting from their centres outwardly. Neither have the tides of the ocean been here referred to, which on my demonstrations prove to be results of reacting or repulsive forces, — the contrary of Newton's Theory, — inasmuch as the swellings of the sea do not correspond with the moon's vertical position as they should if resulting from *direct* attraction; but follow a long time after, when the central attractive force has gradually subsided, allowing a reaction of the repulsive force to ensue, as the earth rotates beyond the lunar meridian. As the centralizing force of spheric gravity is excited into greater intensity when under the sun's and moon's meridians, and acts most intensely in radial lines — i. e. in great circles tangent to polar circles, — through corresponding meridianal aspects of the earth, it follows that similar effects would be produced in opposite hemispheres, and that they would be most feeble in that most remote from the sun and moon. And this we observe to be the case in the action of the tides, and in the action of the magnetic force, this last being only an *index* of molecular motions taking place within the globe in the same manner as the tides act without. Besides, Alexis Perry of Dijon, by great labor, has shown singular correspondences between the age of the moon and many earthquakes, a general fact very probably correct, while my theory referring the primal source of all dynamic forces within both planets and satellites to the sun, will explain all anomalies, and bring all cosmic phenomena, both near and remote, within the range of more accurate inquiry and more certain solution.

To make my conclusions more clearly understood, I will sum them up in a few simple propositions; namely, that an isolated particle of matter *at rest,* is endowed with two embryonic inactive and insensible essences, which

exist *in equilibrio,* as if one force alone existed, or rather *no force* at all; that on the approach of another particle, these essential principles become excited, and develop *active forces* of *attraction* and *repulsion:* that these *two forces* co-exist with particles everywhere; that readily coalescing (like drops of quicksilver, for instance) as particles approximate, these forces become, at last, cosmical units having a power or potential magnitude proportional to the mass of the sphere; that these forces become centralized cosmical powers (absolute living mechanical forces in the universe) which, as *spheric* properties, produce cohesion and density, the intensity of which varies from the centre of a planet to its surface, in *ratios directly corresponding with the force of solar attraction on the whole mass:* that the earth, moving in an elliptical orbit with the sun in one of its foci, is undergoing variations of intensity in its spheric forces with every instant of time and point of space; that these forces BROUGHT BY THE SUN into intense activity at the earth's aphelion, through the *condensation* of terrestrial matter *there,* are never at rest; but holding unequal relations to each other, compel, at each rotation and revolution, perpetual changes of radial action and reaction among *all particles* which end in producing the physical phenomena so observable, and hitherto so mysterious, on the surface of our globe.

OUTLINE OF A THEORY ON THE STRUCTURE AND MAGNETIC PHENOMENA OF THE GLOBE

Mr. J. Drummond, in a communication read before the British Association, at its last meeting at Dublin, from the admitted fact of our earth having cooled down from an original state of fluidity, and that it now is a solid crust inclosing a fluid mass of molten materials, held that there must be an action of the sun and moon on this fluid mass analogous to that which caused the tides of the ocean; that from thence an outward pressure on the crust must result, propagated along it, in a manner similar to the great tidal wave; and from this principle, in an elaborate essay, he deduced the ordinary magnetic phenomena, as well as volcanoes, earthquakes, and other violent actions; concluding by answering objections which may be urged against the foundation and details of this theory.

Readers who are familiar with the views expressed by Dr. Winslow, in his paper, read before the American Association in 1856, and subsequently refused publication in the proceedings of that body, will observe a striking coincidence in the views entertained by Mr. Drummond and Dr. Winslow.

FURTHER INFORMATION CONCERNING THE NATIVE IRON OF LIBERIA.

At a late meeting of the Boston Society of Natural History, Dr. A. A. Hayes read a letter from Mr. A. P. Davis, of Buchanan, Liberia, giving some further particulars in relation to the discovery of Native Iron in Africa.

Mr. Davis, from whom the specimen analyzed by Dr. Hayes was received, in the present letter described the mass found as "being as large as the crown

of a man's hat, and like a rock of a yellow color taken from the earth." — "From its appearance, I supposed it would break into pieces; but it resisted the repeated blows of a sledge hammer of fifteen pounds weight, and I could not separate it by breaking, as the hardest blows only flattened it." — "It was by these means we found out it was malleable." — "The huge bulk was put in the fire and blown to, until it became sufficiently hot to be cut." — "It was divided into many parts, and some of the same bulk was actually ore, not malleable at all."

"It has a very craggy appearance, with many cells in it."

"Where the ore is to be had, or the distance that the ore in question came from, is about four to six days' travel." — "I have none now, but will, with Divine help, get some as soon as possible."

EARTHQUAKES AT SEA.

A recent meeting of the French Academy, reports from two masters of merchantmen were read, stating that on the 30th of December, 1856, the vessel of one was rudely shaken as by a shock of earthquake, in 10° south latitude and 21° 35′ west longitude, and that of the other when under the equator, at 20° west longitude. The first vessel experienced several other shocks, though slighter, accompanied by a rumbling noise until four o'clock in the afternoon; the second only experienced one shock. The weather was perfectly calm at the time, the sea tranquil, and the temperature remained unchanged. After the reports had been repeated, M. Elie Beaumont, the geologist, remarked that it had long been supposed, from preceding observations, that a volcano existed in the Atlantic, at about the latitude and longitude mentioned, and that it was no doubt an explosion of it which had caused the sea-captains to imagine there had been an earthquake.

VOLCANOES IN CENTRAL ASIA.

A late number of the Journal of the Geographical Society of Berlin contains an article by M. Semenoff, a Russian traveller, concerning a volcano discovered by him in Mantchoo Tartary. It has been generally observed that volcanoes, both in the old world and the new, are situated near the coasts; from which it has been inferred that the proximity of the sea exercises material influence on their eruptions. Chinese records, indeed, mention the large inland mountain chain of Thian-Shan as possessing volcanoes, but the only part of this chain hitherto ascertained as such is the Bo-Shan, the last eruption of which occurred in the seventh century. M. Semenoff throws a new light on the subject by producing evidence of the existence of a volcano in the district of Ujun-Holdongi, in Mantchoo Tartary, fifteen versts (nine and a half miles) north of the village of Tomolshin-on-the-Nemer, and twenty-five versts from the town of Mergen. In January, 1721, an eruption occurred there immediately after an earthquake, lasted nine months, and formed a crater eight hundred feet in height, the lava extending over a surface comprised within a radius of forty versts. In May, 1722, a new eruption occurred at a distance of thirty versts north-east of the former, and

lasted a month, leaving a crater one hundred and fifty feet in height. This is the first account we have of these eruptions, and as these two volcanoes are situated at a distance of one thousand versts from the sea, and one thousand two hundred versts from the lake of Baikal, it follows that the proximity of the sea is no essential condition for the existence or formation of volcanoes.

ON THE EXTINCT VOLCANOES OF VICTORIA, AUSTRALIA.

At a recent meeting of the London Geological Society, Mr. R. Brough presented a paper on the above subject.

The district in Southern Australia in which lavas, basalts, and other evidences of recent igneous action are found, extends from the River Plenty on the east, to Mount Gambier on the west. Its extreme length, is 250 miles, and its extreme breadth about ninety miles. In some districts the scoriæ have been found by well-sinkers to overlie, at the depth of sixty-three feet, the original surface of the ground, covered with coarse grass, such as that now found growing; and among this dry, but not scorched grass, the workmen are said to have found some living frogs. Over nearly the whole extent of Victoria there are masses of intrusive basalt, in some places columnar, breaking through both the granite and the palæozoic strata, and occasionally through the overlying tertiary (miocene) beds also. Extensive denudation has destroyed the probable overlying portions of these old basaltic outbursts, both before and after the tertiary period. A newer period of eruptive trap-rocks, sometimes as dense and hard as the older basalts, but more frequently vesicular and amygdaloidal, pierce the older tertiary, and also the post-tertiary beds, or the latter quartzose and auriferous drifts. These newer basalts and lavas were probably erupted at a period when considerable areas, both north and south of the main coast-range, was submerged, and the lavas cooled rapidly, and not under very great pressure. These eruptions do not appear to have disturbed the tertiary beds, which are usually found nearly horizontal. After these newer basaltic lavas were erupted and denuded, and after the deposition of the overlying pleistocene drift, some of the volcanoes were still active (though not so energetic as previously), emitting porous lavas and pumice; and at a still later period volcanic ash and scoriæ, such as that which rests on the ancient humus.

Mr. R. B. Smyth pointed out the interest attached to the extinct volcanoes of Victoria, as connected with the great volcanic chain extending from the Aleutian Islands to New Zealand; and concluded with some observations on the recent occurrence of earthquake movements in Southern Australia, and on the evident uprise of the coast-line, as having reference to the probably not yet exhausted force of the volcanic foci of that region.

ON THE INDENTIFICATION OF THE COAL MEASURES OF PENNSYLVANIA AND THE WESTERN UNITED STATES.

At the Montreal meeting of the American Association for the Promotion of Science, Mr. Leslie stated that, during the past year, Mr. Lesquereux

had succeeded in identifying the coal-beds of Pennsylvania, Kentucky, and Ohio. Thus the Pomeroy coal at the mouth of the Great Kanawha is identified with the Gate vein at Pottsville, on the Schuylkill, and the highest coal bed in Western Kentucky, with the great Pittsburgh bed of Pennsylvania.

The old views, as to the thickness of anthracite coal-series, and the impoverishment of the Western bituminous series, have been incorrect. The number of beds in a given vertical space is no greater in the east than in the west; the intervals are substantially the same; but a more valuable fact is, that the relative values of the beds, among themselves, is maintained.

ON THE SO-CALLED NEW RED SANDSTONES OF THE ATLANTIC STATES.

Highly important additions to our knowledge of the geological character and position of the so-called New Red Sandstones of the Connecticut valley, and of New Jersey, Virginia, and North Carolina, have been recently made through the investigations of Dr. E. Emmons, the State Geologist of North Carolina. This information is contained in Dr. Emmons's preliminary reports to the Legislature of North Carolina, and in Part IV. of American Geology by the same author.

The range of sandstones in question is well known to extend from the north part of Massachusetts, on Connecticut River, southward to Long Island Sound; to begin again on the southern part of the Hudson and continue into New Jersey, and, pursuing a course west of south, to appear in the States of Pennsylvania, Virginia, and North Carolina, even into the bounds of South Carolina, though with interruptions. At the north this series was formerly called the New Red Sandstone, supposed to be, geologically, next above the Coal Formation, and part of the Triassic. On the Continent of Europe, the Trias is divided into *three* parts, the upper called the Keuper, the middle the Muschelkalk, and the lower the Bunter Sandstein. The Muschelkalk is wanting in England and in our country; the other two are admitted in the geology of England, and Dr. Emmons maintains the existence of both in North Carolina and at the north, as the Upper and the Lower Sandstones, separated by their peculiar conglomerates and a partial unconformability. If this is sustained, the Richmond coal-field, and also that of North Carolina, must be placed, not in the Lias, or Oolite series, but entirely below both. In the former relation, Prof. W. B. Rogers placed the coal and sandstone in view of all the evidence attained in 1843. This view Sir Charles Lyell considered to be confirmed by his own subsequent special examination, as he states in his Elementary Geology, sixth edition, p. 330.

The researches and discoveries of Dr. Emmons have, however, changed the character and value of the evidence previously collected on this subject. In Virginia, there are two tracts of these sandstones and shales, of which the eastern, on James River, has long supplied bituminous coal.

There are also two tracts of these rocks in North Carolina, in both of which are coal; in the northern basin, upon Dan river, semi-bituminous

coal, and in the southern, on Deep river, bituminous. In this more eastern and central range, the sandstone and shales extend from Granville County, near Virginia, southeast 120 miles, across the state, to Anson County, and into South Carolina. Near the centre of this series, in Chatham County, is a "plant bed," below which Dr. Emmons found the remains of a large Saurian, named by Leidy, Dictyocephalus elegans, one of the Labyrinthodonts.

In the Chatham series Dr. E. makes known two Saurians, of the Thecodont division, or whose teeth are set in distinct sockets. One of these he considers to be the Clepsisaurus of Lea, because its vertebræ have the hour-glass form, and which is named C. Leai, by our author. The other, Thecodont, Dr. Emmons has named Rutiodon Carolinensis; Rutiodon meaning *wrinkle-tooth*, a fine character on the teeth for the genus, while the specific name commemorates the state of its location. Of this animal Dr. E. figures a "lower jaw, seven inches long, with sixteen alveoles," (sockets).

Dr. Emmons has also discovered, in the Chatham series, teeth of the Palæosaurus, thus making three distinct genera, and at least four, if not five, species belonging to this (Thecodont) section of Lacertilia, in the Chatham rocks. With these also occur, abundantly, coprolites of Saurians.

These discoveries seem to fix the position of the North Carolina Sandstones, as belonging to the Permian group, or else the Bunter Sandstone, as the saurians discovered by Emmons are characteristic of these formations in Europe. Another discovery, however, by Dr. Emmons, seems to offer some objections to this classification. It is that of a *Mammal*, belonging to the Placental Insectivora, of which three jaws have been found. One of these jaws, figured by Dr. E. in his report, is "nine-tenths of an inch long, and contains seven molars, three premolars, one canine, and three incisors," or fourteen teeth in one side of the lower jaw.

These remains belong, undoubtedly, to the oldest fossil mammal hitherto discovered, which has received the name of *Dromatherium* (running wild beast) *sylvestre.* They occur associated with the Thecodont Saurians, before mentioned, and somewhat resemble the remains discovered in the Stonesfield slates of England.

Professor O. Heer, of the Federal Polytechnic School, Zurich, who is distinguished for his knowledge of fossil plants and insects, has recently examined, with great care, the various fossils discovered by Dr. Emmons in the sandstones of North Carolina, and others from Virginia, and as the result of such examination, he maintains that as yet not a single species of plants of the Jurassic series, has been discovered in the Richmond or North Carolina sandstones, but that there are several identical with those of the Keuper in the vicinity of Stuttgart, hence the upper sandstones are equivalent to the Keuper, as Dr. Emmons maintains, and the lower are Permian, or, at least, no newer than the Bunter sandstones (lower Trias). It is also stated that Mr. Lyell, after a full examination of the specimens in the hands of Professor Herr, has arrived at the same conclusions.

In relation to the above discoveries, the substance of which has appeared in Silliman's Journal, Professor Dana makes the following remarks : — In

the determination of the exact age of this sandstone, the only rock in this country east of the Mississippi, occurring between the Carboniferous and the Cretaceous, we cannot be too cautious in the use of evidence. One or two considerations are, therefore, here suggested. In the first place, the Fauna and Flora of America, of this modern epoch, is represented in Europe, and quite strikingly, as has been shown by the Fauna and Flora of the later tertiary of Europe. The life of corresponding ages in the two continents has thus been older in America than in Europe. This is one point to be well weighed. Again, in determining the age of a rock from its fossils, we should rather look to those which indicate the more recent period, than those which bear the other way. This criterion would bring us right with regard to our own epoch, while, by avoiding it, we might be able to prove that we in America are of the Tertiary age of the world. Now, as Mr. Redfield has shown, the fossil fishes, — the most characteristic species of any formation, — are but *half* heterocercal and come nearer to the Jurassic type than the Triassic. There is hence reason for the opinion, notwithstanding the important evidence brought forward by Dr. Emmons, that the Lias period may be represented by the formation ; and we may be nearest the truth if we regard the whole formation as corresponding to the Lias and the latter half of the Trias. The examinations by Mr. Heer accord with this conclusion. The European subdivisions of the Trias we should not look for on this continent, even if we had the whole of the formation, any more than the European subdivisions of the Devonian in the American Devonian. American geology is deeply interested in the decision of this question, and owes much to Professor Emmons for all that he has done towards its elucidation.

FOSSILS OF THE CONNECTICUT RIVER SANDSTONES.

At a recent meeting of the Boston Society of Natural History, President Hitchcock exhibited specimens of impressions, which he supposed to be those of a Myriapod, found at Turner's Falls on Connecticut River.

He also presented specimens of depressions found in the same series of rocks, of regular polygonal forms, generally from five to eight sided, shallow and about an inch in diameter. Similar depressions have been found in the Niagara limestone of New York, of two or three feet in diameter. These last have been referred to the action of tadpoles, and President Hitchcock was also inclined to refer the specimens from Connecticut River to the same cause.

Mr. H. further stated that he was now doubtful if the tracks which he had supposed to have been made by birds, in the Connecticut Valley sandstone, were really produced by birds, since one great argument, namely, that of the number of phalanges in the toe, is lost. Tracks of an animal which was certainly a quadruped, are now found, presenting the same number of phalanges and toes as the *dinornis*.

At the Montreal meeting of the American Association, Dr. Hitchcock also read a paper on the age of the Connecticut River sandstones, and deduced the following conclusions :

1. There is a belt of sandstone lying in Massachusetts, immediately above

the trap, which is the equivalent of the oolitic or jurassic series of Europe, especially the lias.

2. This belt of sandstone is the equivalent of the lower jurassic sandstone of Eastern Virginia and North Carolina, containing very valuable beds of bituminous coal.

3. Hence, workable beds of coal may yet be found in the Valley of the Connecticut.

4. The strata of this sandstone below the jurassic belt are thick enough to embrace the Triassic and Permean groups, and perhaps even more.

5. The upper part of this sandstone formation, the coarse conglomerates of Metawampe, may be found to have a place in the rock series higher than the jurassic.

INTERESTING DISCOVERY OF HUMAN REMAINS.

At a recent meeting of the Boston Society of Natural History, Dr. A. A. Hayes communicated a letter from Dr. C. F. Winslow, containing an account of the discovery of a fragment of a human cranium, one hundred and eighty feet below the surface of Table Mountain, California. The letter, which was accompanied by a portion of the bone in question, says:

"My friend, Col. Hubbs, whose gold claims in the mountains seem to have given him much knowledge of this singular locality, writes that the fragment was brought up in "pay dirt" (the miners' name for the placer gold drift) of the Columbia claim, and that the various strata passed through in sinking the shaft consist of volcanic formations entirely. Whether his knowledge is accurate touching the volcanic formations, I have some doubt, and have written for more certain information.

"The mastodon's bones being found in the same deposits points very clearly to the probability of the appearance of the human race, on the western portions of North America at least, before the extinction of those huge creatures. As I have fragments of Mastodon and Elephas primigenius, or a kindred species, taken between ten and twenty feet below the surface, among the upper placer gold deposits of the same vicinity, it would seem that man was probably contemporary, for a certain period, with the closing dynasties of these formidable races of quadrupeds. This discovery of human and mastodon remans in the same locality, gives also great strength to the possible truth of an old Indian tradition of the contemporary existence of the mammoth and aboriginals in this region of the globe."

NEW FOSSIL OPHIDIAN.

At a recent meeting of the London Geological Society, Professor Owen called attention to the remains of a fossil ophidian, obtained near the Bay of Salonica, Greece, from beds of fresh water tertiary. The vertebræ were thirteen in number, indicating by their size a serpent of between ten and twelve feet in length.

Supposing them to have been derived from other parts than the anterior

fourth part of the trunk, they resemble in the length of the hypapophysis the vertebræ of *Crotalus, Vipera* and *Natrix;* which they also resemble in the presence of a process developed from both the upper and lower part of the diapophysis. The results of a minute comparison of all the parts of the complex vertebræ of ophidian reptiles were given, which rendered it probable that the Salonica fossil serpent resembled those genera in which the hypapophysis is well developed from all the trunk vertebræ; the breadth of the base of the neural arch indicates that they have been from about the middle of the trunk. They offer so many points of resemblance with those of the rattlesnake and viper, that they may have belonged to a venomous species, but they are specifically distinct from those existing serpents; they differ generically and in a very marked degree from the vertebræ of the great constricting serpents (*Python* and *Boa*), as well as from the large fossil serpent (*Palæophis*) of the Eocene Tertiary formations. A summary of the known existing serpents of Southern Europe and Asia Minor was given, showing that none of the living species equal in bulk the fossil serpent. "A classical myth embalmed in the verse of Virgil, and embodied in the marble of the Laocoon, would indicate a familiarity in the minds of the ancient colonists of Greece with the idea at least of large serpents. But according to actual knowledge, and the positive records of zoology, the serpent between ten and twelve feet in length, from the tertiary strata of Salonica must be deemed an extinct species." For this fossil Professor Owen proposed the name of *Laophis crotaloïdes.*

NEW FOSSILS FROM THE POTSDAM SANDSTONE.

Hitherto the Potsdam Sandstone of New York, the lowest rock of the Silurian, has been known to afford no fossils but one or two species of the genus Lingula. Through the researches of Mr. F. H. Bradley, of New Haven, a species of Trilobite (genus *Calymene*) has been discovered, and also one of *Pleurotomaria*, besides an impression of a crinoidal disc. The Pleurotomaria is only a cast. The Trilobite, although a small one, its breadth but one eighth of an inch, is well preserved. The buckler and caudal extremity have not been found together, but the markings of each are very distinct.—*Proceedings Montreal Meeting American Association.*

FALL OF A LARGE MASS OF METEORIC IRON IN SOUTH AMERICA.

Mr. R. P. Grey communicates to the Philosophical Magazine the following account of the fall of a large mass of meteoric iron at Corrientes, in South America, as given in a letter, by an observer of the phenomenon, a Mr. H. E. Symonds. He says: In 1844, I accompanied the Corrientine army in its invasion of the province of Entre Rios. One morning in January, when encamped on the river Mocorita, near the Corrientine frontier, we were all awaked from a profound sleep, and every man of the army of 1400 sprang on his feet at the same moment. An aërolite was falling. The light that accompanied it was intense beyond description. It fell in an

oblique direction, probably at an angle of about 60° with the earth, and its course was from east to west.

Its appearance was that of an oblongated sphere of fire, and its track from the sky was marked by a fiery streak, gradually fading in proportion to the distance from the mass, but as intensely luminous as itself in its immediate vicinity. The noise that accompanied it, though unlike thunder, or anything else that I have heard, was unbroken, exceedingly loud and terrific. Its fall was accompanied by a most sensible movement of the atmosphere, which I thought at first repellent from the falling body, and afterwards it became something of a short whirlwind. At the same time I and my companions all agreed that we had experienced a violent electric shock; but probably this sensation may have been but the effect on our drowsy senses of the indescribably intense light and noise. The spot where it fell was about one hundred yards from the extreme right of our division, and perhaps four hundred from the place where I had been sleeping. Accompanied by our general (Dr. Joaquin Madauaga), I went within ten or twelve yards from it, which was as near as its heat allowed us to approach.

The mass appeared to be considerably imbedded in the earth, which was so heated that it was quite bubbling around it. Its size above the earth was perhaps a cubic yard, and its shape was somewhat spherical; it was intensely ignited and radiantly light, and in this state it continued until early dawn, when the enemy forced us to abandon it to continue our march. I may mention, that, at the time of its fall, the sky above us was beautifully clear, and the stars were perhaps more than usually bright; there had been sheet lightning the previous evening.

I never afterwards had an opportunity of revisiting the Mocorita, for our permanent encampment was thirty-five leagues to the north of that pass, between which and our encampment the country was entirely depopulated by our long war; but as the spot where the aërolite fell was known to many of our subaltern officers, who were frequently sent to observe the frontier of Entre Rios, I have heard them describe it as a "piedra de fiérro; that is, a stone of iron; and I once provided one of the most intelligent of them with a hammer in order that he might bring me a sample of it. On his return he told me it was so excessively hard that the hammer bent, and was broken in unsuccessful attempts to break off a small piece of it.

MINERAL PRODUCTS OF GREAT BRITAIN FOR 1856.

From the reports of the keeper of the mining records of Great Britain, published August, 1857, we derive the following correct data respecting the mineral productions of Great Britain for the year 1856:

The value of the mineral produce of the United Kingdom in 1856, at the mine, colliery, or quarry, before any charges for carriage were made, or cost added in any way for manufacture, was upwards of thirty millions and a half sterling, as follows:

Tin,	£663,850
Copper Ore,	2,343,960

Lead and Silver,	£1,431,509
Zinc Ore,	27,455
Iron Pyrites,	46,066
Iron Ore,	5,695,815
Arsenic,	1,911
Nickel and Uranium,	527
Coals,	16,663,862
Salt,	553,993
Barytes, etc.,	10,000
Porcelain, etc.,	120,896
Building Stones	3,042,478
	£30,602,322

Of all these substances, says the report, the quantities obtained in 1856 are larger than those of the preceding years, but of coals the increase is something extraordinary. The money value of coals is now more than half that of all the other mineral substances put together, and the increase in quantity is upwards of *two million tons.* The coal produce of last year as compared with the two preceding years, is as follows:

1854	64,661,401
1855	64,453,070
1856	66,645,450

Of this increase of the raising of coal nearly one half has been wanted for export, while the remainder has been called for by the enormous increase of our iron manufactures and railways. Nearly one-fourth of the whole amount of coal raised in the United Kingdom is the produce of the mines of Durham and Northumberland. Those two counties are being undermined at the rate of fifteen millions of tons per annum, and yet, say geologists, we have no need to fear a supply of coal falling short for some hundreds of years.

DEEP SEA-SOUNDINGS.

In connection with the surveys instituted in behalf of the trans-Atlantic telegraph, some highly-important explorations, by means of deep sea-soundings, have been made during the past year by Capt. Berryman, U. S. N., of the surveying steamer Arctic.

Soundings were made and submarine temperatures observed at depths varying from eight hundred fathoms to three miles. Compared with these results, the observations of others in comparatively shoal water, are of minor interest. In every instance specimens of the bottom were obtained, generally of what appeared a dark blue mud, but which, when examined with a powerful glass, exhibited the same curious microscopic revelations observed in the specimens from the telegraphic plateau. But the most curious points were the temperatures of the bottom of the ocean. So imperfect is the apparatus for registering these submarine temperatures, that contradictions will arise, but a constant repetition of experiments has proved that at a depth of three-fourths of a mile and over, there exists a degree of cold unknown on the surface.

At times the Saxon thermometers registered a temperature below zero. On one occasion, attaching two to the same sounding, they registered at a depth of a thousand fathoms ten and eleven and one quarter degrees respectively. On the next trial, at a depth of 1076 fathoms, both registered ten degrees. In 1296 fathoms water, the two thermometers in use indicated, the one ten, the other eight degrees, while in nearly every case where a comparison could be made between the registration of two or more, a greater difference than ten degrees was very rare.

Some of the depths obtained were enormous — the greatest reliable depths ever obtained. In every instance ample specimens of the bottom were brought up, and the depths as recorded by the little sounding apparatus and the amount of line expended were in very exact agreement.

FOSSILS FROM THE CRIMEA.

The temporary occupation of the Crimea during the war led to some interesting geological discoveries. Specimens of fossils from the various strata were sent to England, and with these, including some formerly sent from St. Petersburg, seventy-four specimens have been added to the published list of fossils from that country. These fossils, with one exception, belong to the invertebrata. The geological formations show the probability that, at one time, the Caspian and Aral, with the Black Sea, formed a vast inland sea, now separated by the gradual filling up of the communication between them. The existence of coal deposits had been rumored, but these proved to be lignite of ordinary quality.

NEW FOSSIL BIRD.

At a recent meeting of the French Academy M. St. Hilaire announced that a fossil bone of a bird had been lately discovered at Armagnac, department of the Gers, in France. The bone was described as a humerus of the right side, and as one-third longer than that of the common albatross, which is the longest of those of living birds; but between it and the humerus of the albatross there are various differences. M. St. Hilaire stated that he had come to the conclusion that it belongs to a peculiar and distinct branch of the palmipeds, to which he proposed the name of *Pelagornis miocœnus*, in order "to recall the presumed habits of this great bird, and the geological period in which it lived."

BOTANY.

NEW FACTS IN ARBORICULTURE.

Two branches of a tree may not unfrequently be observed to produce a perfect bifurcation; that is, they separate from a common point. Further examination will show that such branches take their departure from one and the same bud. In rarer instances, five or six branches may be observed to all start from a common centre, and with a regularity that surprises, when contrasted with the arrangement of the rest of the tree. These effects are now and then produced by germing, or inoculating, and not seldom by the unassisted handiwork of nature. When the latter is the case, the bifurcation is caused by the bite of a caterpillar, or some other voracious insect, which has but to gnaw the point of a bud to make it grow double, triple, quadruple, and so on — to transform itself indeed into numerous buds, thereafter distinct and separate, each passing singly through all the phases of its vegetation.

What is here said applies to buds that produce wood; it is equally true of those that produce fruit. The insect plies its mandibles, and quite unconsciously starts a new order of developments. After all, however, a little reflection would lead us to believe that buds might be as fecund as seeds. If one grain of wheat produces many grains, why not one bud many buds, if we can only get it into the right condition? What this condition is, we learn from the insect.

At all events, it has been learned by M. Millot-Brulé of France, and turned to good account, for he produces effects at pleasure, without waiting for the accident of an insect; with the point of a penknife, or a slip of sand-paper, he makes buds produce as many branches as he chooses. The notion occurred to him in 1849; and he at once made experiments which were successful: and repeating these year by year, he has now produced a new and singularly interesting process of arboriculture. A commission appointed by the Minister of Agriculture and Public Works to examine into it, reported in the following terms of what they had seen in M. Millot-Brulé's gardens: "Several peach-stems present a multiude of branches proceeding from the same centre with mathematical regularity and symmetry. By skilful disbudding by incisions, and nipping of the buds or shoots, he arranges the trees in a way at once the most picturesque and fantastic. Under his fingers, the obedient branches assume the most varied and elegant

forms: he increases the fructification, and develops the formation of buds according to his wish."

Thoroughly to illustrate the results, diagrams would be necessary; we shall, however, endeavor to explain as clearly as the subject will admit of. M. Millot-Brulé's elementary figure consists of a straight branch which from one common tentre separates into fifteen branches, resembling, in fact, a small tree with a regularly-formed head. A second represents an espalier peach tree, the branches of which radiate in the form of a wheel, each branch terminating in an oval ring of smaller branches, developed at regular intervals. From these simple forms, others of a more complex nature may be produced; a single stem, properly managed, will form a square, a parallelogram, of a series of circles, so elegant in design, that if copied in papier maché they would be prized as graceful ornaments for the drawing-room. The buds may be multiplied, and the branches sent off entirely at the pleasure of the cultivator; hence there is no limit to the forms which may be produced.

In the course of his experiments, M. Millot-Brulé discovered another of the interesting secrets of arboriculture, namely, that little branches must not be developed immediately opposite each other on a horizontal branch trained against a wall or on stakes; and the reason is, that the branches which run upwards take up all the sap at the expense of those running downwards; the latter consequently languish. It therefore becomes absolutely necessary to develop the small branches alternately — each lower one between two upper ones — on all horizontal branches. It is possible, moreover, to assist the lower branches by bending the upper ones upon themselves, making them form a sort of knot, but always with the precaution of leaving the extreme points in an upward direction.

Any intelligent person may, by a little dexterity, become a practised arboriculturist. The process in its simplest form appears to be to decapitate the buds with a penknife as soon as the sap begins to circulate in the spring. In a few days, two new buds appear at the base of the bud thus operated on, and the vegetation of these is easily equalized by expert trimming, or pinching off when necessary. The equilibrium once established, these two buds may be similarly treated, and as each will produce two more, any number of branches may be obtained, and a thick full head developed on the top of a single stem. To make branches shoot in different directions, the terminal bud of the main branch is pinched at one side or the other, according as the direction required is to the right or left; and the new buds being pinched in turn, perfect control is established over each branch from its very earliest growth. We pretend not to enter into the minute details that would be requisite in a horticultural publication: all we propose is to convey some general notion of what strikes us as a remarkable discovery.

Wires are used when necessary to maintain the branches in a proper position; and from this point we are led to a consideration of practical use and value. This method of multiplying branches being introduced into nurseries, the trees grown will be more fruitful and less irregular in form than heretofore. Who would not rather see a shapely tree than a straggler!

It will enable landscape-gardeners to make single trees or groups as ornamental as they please. Parks may thus become more beautiful than ever, and public walks, boulevards, and the like, may be decorated according to taste or fancy. There are many persons who will, perhaps, say that trees are most beautiful when left entirely to nature; but they forget that nature sometimes produces vegetable as well as animal deformities, and that it must therefore be an advantage to be able to encourage gracefulness.

But M. Millot-Brulé's method admits of an immediate and eminently useful application — namely, that of controlling the form of branches in plantations grown for their timber. In agricultural implements, in ship-building, fancy cabinet-making and carpentry, as well as in other employments that will suggest themselves to the mind, angular, forked, and bent timber is an article of prime necessity. What an advantage is gained to the grower when, using his judgment, aided by his penknife and a slip of sand-paper, he can make the trees under his care obedient to his will.

ON THE COLORING OF THE SKIN OF FRUITS.

The following article, by M. Flotow, is translated from the French "*Journal de la Societe Imperiale of Centrale d'Horticulture.*"

"Duhamel, in his Treatise on Fruit Trees, says, that to encourage the coloring of kernel fruits, it is merely necessary, when they have attained their full size, to remove the leaves which shade them, first from one side, then from the other, and finally all round. He adds, that their coloring may be rendered more brilliant by marking the side next the sun with a hair pencil dipped in cold water. This passage applies more especially to pears. It suggested to M. de Flotow experiments, the results of which he has given in a lengthened article on kernel fruits in general. He selected some favorably situated fruit of the Napoléon, Beurré d' Hiver, B. Diel, Merveille de Charneaux, and more particularly of the Poire longue blanche de Dechant, on which he had never observed at the time of ripening the least degree of redness, whilst the other varieties had several times exhibited a little red approaching to yellow or brown. He moistened these in the morning, and repeated the operation several times during the day, when the sun shone upon them; and he continued this treatment as long as the weather permitted. The result of this experiment has justified the assertion of Duhamel. All the fruits thus moistened were remarkable among others of the same variety and on the same tree, by a more brilliant red. The Poire de Dechant, in particular, exhibited a decided red tint, while the fruit usually presents no such appearance.

"M. de Flotow had remarked, but without being able to account for the fact, that in apples and pears which were striped on both sides, the rays or stripes were longitudinal, that is, from the eye to the stalk, but never transversely, although he says that in several works on pomology, fruits are figured with the stripes in the latter direction. The results of the experiments have led to the conclusion that the action of the sun's rays upon the skin of fruits wetted or moistened by dew, is the cause to which the produc-

tion of these red bands is to be assigned. If, says he, fruits wetted by dew are observed whilst the rays of the rising sun strike upon them, it will be seen that the moisture collected in drops on the edge of the cavity in which the stalk is inserted, and on the sides, forming lines of moisture, of greater or less length, according to the size of the drops, and according as the sun evaporates them with greater or less rapidity. It will be understood that there must be great differences in the streaking, according as the dews are more or less frequent, according as they are light or heavy, and according to the power of the sun's rays and the fineness of the skin. It is likewise probable that the difference between the day and night temperatures has some effect in this respect; and streaked fruits are generally autumn or winter varieties. Pears are seldom streaked, or, at least, not distinctly so.

To throw some light upon the coloring of fruits, M. de Flotow has tried the action of acids and alkalies upon the skin. The following are briefly the principal results of his experiments: Strips of skin, removed from the fruit and cleaned, became intensely red when treated with diluted sulphuric acid; at the same time they yielded a red juice. The color only became brighter and more beautiful when treated with diluted hydrochloric acid. Ammonia restored the original color. Other pieces of skin having been, in the first place, treated with ammonia became brown, and their color darkened to such a degree that they appeared black; on the application of diluted sulphuric acid their natural color was speedily restored. The Pomme douce d' Amerique, which is streaked with bright red and pale yellow, underwent no particular change when treated with sulphuric and hydrochloric acids, the red lines only becoming a little more conspicuous; and with ammonia they became of a blackish-brown color.

Whilst leaving to botanists and chemists the explanation of these facts and several others contained in his memoir, M. de Flotow believes, however, that he can conclude from them that the matter which reddens the skin of fruits is totally different from the green matter which is also found there; and that it likewise extends to the flesh immediately under the skin

VITALITY OF SEEDS

The report of the standing committee of the British Association, on this subject, was read at the Dublin meeting by Dr. Daubeny.

They state that after planting, year after year, all the seeds they were able to collect, they had now left, but four species of plants whose seeds continued to grow. These were seeds belonging to the species Ulex, Dolichos, Malva, and Ipomea. The results are curious and interesting. We now give them for the information of our readers, and for reference. The register of every experiment was exhibited with the details kept by Mr. Baxter of the Botanic Garden. From this register it was seen that the shortest period for which any of the seeds had retained their vitality was eight years, and the longest forty-three years. Grouping the plants according to their natural orders, the following, selected, will give some idea of the plants whose seeds retain their vitality longest; Gramineæ, eight years; Liliaceæ, ten years; Coniferæ,

twelve years; Tiliaceæ, twenty-seven years; Malvaceæ, twenty-seven years; Leguminosæ, forty-three years; Rhamnaceæ, twenty-one years; Boragniaceæ, eight years; Convolvulaceæ, fourteen years; Compositæ, eight years; Myrtaceæ, eighteen years; Umbelliferæ, eight years; Cruciferæ, eight years. It would appear that the seeds which retained their vitality longest were those which had least albumen surrounding their embryos, as the Leguminosæ; while those which had large quantities of albumen, as the Graminaceæ, lost their vitality soonest. Dr. Steel stated that he had planted many seeds obtained from Egyptian mummies, but always failed to obtain any indications of their vitality. Mr. Moore, of the Dublin Botanic Garden, related an instance in which he had succeeded in producing a new species of leguminous plant from seeds obtained by Mr. John Ball from a vase discovered in an Egyptian tomb. He also stated that he had picked from out of the wood of a decayed elm, at least fifty years old, seeds of laburnum, many of which had germinated when planted, and produced young trees. He had once grown a crop of young barberry trees, by planting a quantity of barberry jam, which proved that the process of preparing the jam did not injure the seed. Many seeds grew the better for being placed in boiling water before they were set. Dr. Daubeny stated that seeds did not retain their vitality whilst entirely excluded from the air; that, in order to keep them well, they should be wrapped up in brown paper, or some other porous material. Mr. Archer stated that the seeds sent from China in air-tight vessels always failed to germinate. Some seeds kept much better than others. Mr. Ogilby stated that some seeds germinated the better for being kept. Mr. Nevins and Mr. Moore both confirmed this statement, and said that gardeners were in the habit of keeping cucumber and melon seeds in their pockets, in order to insure their more efficient germination.

MAMMOTH TREES OF CALIFORNIA

During the past year two new localities of the mammoth trees of California *seguoia gigantea,* have been discovered in Maraposa County, those formerly known and described being situated in Calaveras County.

The valley in which one group of these trees occurs is nearly half way between the town of Mariposa and the falls of the Yosamite. Here, accordin to the editor of the California Farmer, more than 150 trees are growing, no one of which measures less than fifty feet in circumference. One tree measured 102 feet in circumference, at the ground, and ninety feet at a point three feet and a half above the ground. Its height was upwards of 300 feet. The circumference and height of a large number of other trees, growing contiguous, were also found to be but little inferior to the one specified.

ZOOLOGY.

ON THE INFLUENCE OF ART UPON ORGANIC STRUCTURE.

Prof. George Wilson of Edinburgh, in a recent article, thus notices the extent to which living organisms are influenced by art, and rendered machines and apparatus, which can be weilded to a certain degree at will.

A cattle dealer will give you one calf, which shall certainly, in course of time, prove a bountiful yielder of milk and cream; another, which shall as certainly be a fatted ox when three years old; a third, which shall by and by be a match for a horse at the plough. The Yorkshire broadcloth makers choose by preference the long-stapled wool of sheep fed plentifully upon artificial grasses, turnips, and the like. The Welsh blanket makers, on the other hand, prefer the shorter wool of sheep cropping the natural grass of the hills; whilst the Scotch tartan-shawl weavers work only with Australian or Saxon wools. In like manner, the comb-makers will tell you that the farmers are injuring them, by multiplying breeds of cattle which quickly fatten, and are, in consequence, killed before their horns are well grown; and those same industrialists will curiously distinguish between the tortoise-shell from one region of the sea and that from another. I should never end, were I to pursue this matter.

THE MICROSCOPIC COLLECTION OF THE LATE PROFESSOR BAILEY.

The Microscopic collection of the late Prof. Bailey, of West Point, was by the will of its owner, bequeathed to the Boston Society of Natural History. This collection, embracing specimens, mounted and prepared for preservation and examination, books, drawings and rough material, is far superior to any similar collection in this country, and is probably not surpassed by any in Europe. As the object of Prof, Bailey in bequeathing this valuable collection to the Boston Society, was, that it might be made most available to the general interests of science, we think we shall do good service by enumerating somewhat in detail the materials which hereafter can be made available for consultation by all microscopic investigators.

The Microscopic Collection, which comprises the most valuable portion of the specimens mounted for the microscope, is contained in twenty-four boxes in the shape of octavo volumes.

Five of the boxes contain specimens of Diatoms, etc., from the Atlantic

Soundings, including two boxes from Lieut. Berryman's Soundings between America and Ireland, in 1856.

Three boxes contain specimens from Soundings in the Arctic and Pacific Oceans, Gulf of Mexico, and Para River, etc, in South America.

In four boxes are American and Foreign Diatoms; Diatoms in Guano; and Fossil Polycistins and Diatoms from Barbadoes.

In three boxes are Fossil Diatoms from Virginia and Maryland; Bermuda, Monterey, California, Suissun Bay, etc.

Nearly all the specimens in the above boxes were mounted by Professor Bailey; and they are accompanied by manuscript catalogues, or by memoranda on slips of paper, in which the positions of more than three thousand individual objects on the slides are noted with reference to Bailey's Universal Indicator for Microscopes; thus enabling the actual specimens described by him to be readily found and identified at any future time. A part of the collection is also accompanied by an alphabetic catalogue of species, with reference to the slides on which specimens may be found.

Two boxes contain recent and fossil Vegetable Tissues; and two others Test Objects and miscellaneous organic bodies, and a micrometer scale on a glass slide.

The number of glass slides in these twenty-one boxes is five hundred and fifty.

In addition to the selected specimens in the Microscopic Collection, there are more than eight hundred specimens mounted on glass slides, comprising many duplicates of those in the collection, and a variety of miscellaneous microscopic objects.

There are also two hundred specimens of Polythalamia mounted as opaque objects and labelled. These are not duplicates of the Polythalamia in the Microscopic Collection, which are in Canada balsam.

A very valuable portion of the bequest consists of the original specimens of microscopic material, collected by various scientific and exploring expeditions, and an extensive series of specimens received from European correspondents, including Ehrenberg and other distinguished microscopists.

The Algæ are contained in thirty-two portfolios. They are from almost every part of the globe. They are arranged and named in a manner to afford great assistance to the student, who may be interested in the study of marine botany. In most instances, specimens of the same kind, but collected at different seasons of the year, or brought from different localities, and presenting different appearances to the naked eye, are placed side by side upon the same sheet, or within the same envelop, so that the work of comparing one specimen with another, and of ascertaining the names of doubtful ones, which the student may possess, is rendered easy. The whole number of specimens in this department of the collection is about four thousand five hundred. Of this number nearly one half belong to the family Floridæ, and comprise about two hundred varieties.

The collection also includes sixty-nine specimens of animal tissues, of vertebrata, articulata mollusca and radiata.

The whole number of books belonging to the collection is eighty-four,

besides one hundred and fifty unbound volumes and pamphlets, and these latter are not the least valuable portion of the library, consisting as they do of important monographs, a form in which much that has been done in Algology and Microscopy is as yet only to be found. Among the works are the splendid Microgeologie of Ehrenberg, the works of Kützing, Queckett, Ralfs, Hassall, Smith, Agardh, Harvey, Lindley, and Hutton. Indeed, nearly everything of importance relating to microscopic science is here. In addition to the books, there are nearly three thousand sketches or drawings of microscopical objects, all carefully arranged and catalogued.

PRODUCTION OF SEXES AT WILL.

Many curious investigations have been instigated in regard to this point in the world of nature. It is a matter of familiar knowledge that the male and female characteristics of the higher species of the animal creation, are not produced in the same individual as they are in the great majority of the higher species of plants. The organs, as will be seen, from which the two are evolved, are, however, so nearly related to each other in intimate nature, that the one may be readily mistaken for the other in the earliest period of their formation. Physiologists now incline to the opinion that the fertilizing vesicle is merely a germ vesicle, in a somewhat more exalted state of development. Mr. Knight has shown that plants, like the oak, that bear the male and female flowers on separate individuals, may be made to produce either at will, by regulating the supply of light and heat according to the end in view. If the heat be excessive as compared with the light, male flowers only appear; but if the light be in excess, female flowers are produced. He also found that whenever the eggs of birds are not allowed to be fertilized until immediately before they are laid, and therefore their own intrinsic development has been carried to the highest possible pitch before renewed vivification of the germ vesicle is effected, as many as six out of every seven of the birds subsequently hatched proved to be males. * * * Quetelet believes that the relative ages of the male and female parent, influence the sex of the offspring produced, to a very considerable extent. In support of this theory M. Hofacker has shown that when the father is considerably younger than the mother, the proportion of female to male children is generally as ten to nine; but that when, on the contrary, the father is nine years older than the mother, the proportion of male offspring to female is as five to four, and when eighteen years older, as two to one. In a general way, more males of the human species are born into the world than females. If all Europe be included in the estimate, the proportion of male to female births is about 106 to 100. Possibly, if Quetelet's views be based on truth, this preponderance on the side of males may be due to the fact that in civilized communities men, from prudential and other motives, mostly marry women younger than themselves. But there are other reasons why this preponderance exists. Three male children are born dead to every two female.—*Gardner on Sterility.*

ON THE HABITS OF FISHES.

At a recent meeting of the Boston Society of Natural History, Capt. A. E. Atwood, of Provincetown, Mass., an old and experienced professional fisherman, and also a distinguished investigator in science, submitted to the Society some interesting facts respecting fishes and their habits, the result of his personal observations.

He first remarked upon the senses of taste, smell, sight, and touch. It has been said by eminent ichthyologists that taste and smell are very imperfectly developed in fishes; but this is not the fact. Many fish are very particular in the choice of food; others, such as the mackerel and blue-fish, and mid-water and top-water fish generally, seem to be governed by sight in their selection of food. He had often seen mackerel, when they were abundant around a vessel, take all the bait that was thrown overboard, but at the same time carefully avoid the baited hook. He had also noticed that tobacco thrown overboard was seized by mackerel but immediately rejected, showing as he thought a sense of taste. It is to be presumed, however, that taste must be imperfectly developed in animals which have a tongue more or less cartilaginous, and covered with recurved teeth; being obliged unceasingly to open and close the jaws for the purpose of respiration, they cannot long retain food in the mouth, but are obliged to swallow it without mastication.

The sense of smell seems to be well developed in some fishes. For instance, the ground swimmers generally have a choice as to their food. Halibut and cod are attracted a great distance with certain kinds of bait. Herring, when fresh and in good condition, will be very readily taken by cod, but when it has become stale from long keeping, it will be rejected. Crustaceans, also, as lobsters and crabs, are attracted by certain bait, which leaves no doubt that they likewise possess some sense of smell. Although the cod seems to swallow almost anything that comes in his way, even stones, wood, and fragments of nearly everything thrown overboard, Mr. Atwood had never seen an univalve mollusk in its stomach. The bivalve shell is found, and the bank clam is very common in the stomach, the shells being placed within each other in the most compact manner, when there are several of them in that organ.

In some other ground swimmers, both bivalve and univalve mollusks are found. The haddock, ling, catfish, and one species of flounder are great shell-eaters, and very frequently undescribed species of mollusca are taken in their stomachs.

The cod lives mostly upon live fish. It is very greedy, and even when distended with food, it will bite briskly at the hook. It is frequently taken with a full grown mackerel partly in its stomach and partly in its mouth, with the tail still projecting. At other times, when the alimentary sack is empty, it appears to have no desire to partake of food. When kept alive in the holds of vessels, no other nourishment is given the cod than the minute animalcules contained in the water. A very curious fact Mr. Atwood stated that he had observed, — the cod often swallows alive the tant or sand-eel

and the pipe-fish, both having heads very much elongated anteriorly and pointed. These fish sometimes pierce the stomach of the cod and escape into the abdominal cavity, and there they are found in a perfect state of preservation, adherent to its walls, but changed in color to a dark red, and in substance so hard that they are not readily divided with a knife. They have to be cut away before the cod can be split open. The fish is always in good health, apparently, and there are no marks of inflammation about the stomach or abdominal cavity, unless the material of attachment be considered as such.

Fish migrate considerable distances in quest of prey, sometimes totally deserting localities where they have been very abundant. There is a species of crustacean called commonly by fishermen the sea-flea, which infests spots upon the Grand Banks, hundreds of square miles in extent, and which drives before it the cod and other fish. During his last voyage to the Banks, Captain Atwood tried to fish with clam bait, which, however, came up untouched; he then put on menhaden for bait and lowered to the bottom, but upon raising the hook nothing was found but the skeleton of the fish, the soft parts having been consumed by the sea-flea.

ARTIFICIALLY REARED FISH.

At a recent agricultural and industrial exhibition, in Paris, about three thousand fish were exhibited from the Artificial Piscicultural Establishment formed at Thuringen by the French government. They consisted of salmon, from the Danube, trout, from the lakes of Switzerland, and grayling from the Lake of Constance. The last named were products of eggs hatched during the spring of 1857. There were also salmon of three years, some of which measured nineteen inches long by thirteen inches in circumference. These fish were conveyed in cylindrical reservoirs made of tin, the water being renewed frequently.

It is tolerably well ascertained that the growth of artificially-reared fish, particularly salmon, is less rapid than under ordinary circumstances. Left to nature, the salmon will grow to about twenty-five pounds in three years; reared and fed at the piscicultural establishment at Thuringen, he will not, in the same time, have reached a weight of five pounds.

From information gained at the salmon-breeding establishment, in Scotland, it also appears probable that there is a very singular retardation in the development, and that the young of salmon, under certain circumstances, continue to hold their generic character for an indefinite period, instead of assuming their last metamorphosis. The question, then, may be asked: Is it then a law that of the ova of a single incubation a certain number become fully developed after a residence in the fresh water of a few weeks — a certain number at the end of a year — and a still greater number never, but, retaining their generic dress, continue in this dwarfish state in the fresh-water rivers?

INTERESTING PHYSIOLOGICAL RESEARCHES.

The following is an abstract of a communication recently made to the Boston Society of Natural History, by Mr. Brown Séquard.

Experiments have lately been made to determine if the introduction of air into the chest, through the respiratory passages, with great force, does not have some influence upon the action of the heart; and it has been found that there is a diminution in the frequency of the heart's action, sometimes to such an extent, that the pulsations amount to only two-thirds the normal number.

The explanation which has been given to this phenomenon is based upon mechanical grounds, but M. Séquard thinks, if this explanation be correct, it is so only to a certain extent. One other cause at least, that of a nervous influence, he has demonstrated to exist.

It is well known that some mammals resist asphyxia for a long time, making efforts to breathe, often for several hours when the entrance to the lungs is closed. Now it is found that when the chest of an animal in this condition is opened and retained in such a position that there can be no motion and no mechanical action, the diminution of the pulsations persists. The phenomenon is then due to the action of the *par vagum nerve.* It is found that when this nerve is irritated at its root or galvanized, the action of the heart is arrested; in this respect differing from the other muscular organs, which are excited to action by irritation or galvanization of their nerves. When the chest is opened, without injury to the par vagum, there is seen to be a control over the action of the heart during inspiration. But if the par vagum of both sides of the chest be cut across, this control is lost. There is good ground for belief, therefore, that at every effort of inspiration, there is a transmission of nervous influence along the par vagum to the heart, acting as a check upon it and regulating its action, and thus preventing the increase of pulsation, which might otherwise go on, in increased ratio to infinity, under the excitement of forced respiration.

It has been said that people have killed themselves by stopping the heart's action. One of the brothers Webber, of Leipsic, found that when an effort was made to contract the chest during a full inspiration, that there was great suffering, fainting, and almost death. Webber himself nearly lost his life trying the experiment. By irritating the various organs which receive branches from the par vagum, as the stomach, spleen, etc., by galvanizing them or crushing them at once by a blow of a hammer upon an iron surface, it is found that the heart's action is diminished in frequency, and in some instances entirely suspended. Cases of sudden death from a blow upon the stomach, externally, are to be attributed to the same cause. The action upon the heart from overloading the stomach, either with too much solid or liquid matter, is to be explained also by the influence of the par vagum upon the heart.

Dr. Séquard also referred briefly to his researches upon the Supra-renal Capsules. These two small organs, lying in immediate connection with the kidneys, have been considered very unimportant until within a few years. Now it is found, that when they are removed from the body of a living animal, there occurs a very great change in the blood, and the animal dies in a short time, — sooner even than after the removal of the kidneys. There is

found also to be an accumulation of pigment and a peculiar form of crystals (not having the chemical reactions of hæmatoidine), in the blood.

In answer to an inquiry, if the real use of these capsules was known, M. Séquard replied that his hypothesis was *that the function of the supra-renal capsules was to prevent the formation of pigment in the blood*, and he thinks he has isolated a substance from the blood, which would be changed into pigment without the agency of these organs. This substance, perhaps, may be introduced in such a quantity that the capsules cannot destroy it, even when they are in a healthy state. In the disease described, a short time since, by Dr. Addison of London, and known as *bronzed-skin disease*, the coloring matter of the skin, examined under the microscope, proved to be the same as that of the negro's skin. And, as in the blood of the same disease, pigment-cells, pigment-granules contained in a transparent substance different from fibrine, and peculiar crystals of an unknown substance, just referred to, are found, he thought there was some ground for the hypothesis that these organs are pigment-destroying agents. He had seen the crystalline plates sufficiently large to become impacted in the capillaries and prevent circulation of the blood, and consequently he believed if they were not the prime cause of many disturbances of the nervous influence, they should at least be considered a partial cause. He had likewise observed an absence of blood-discs in the vena cava, which would imply a great alteration of the blood.

ON THE EXISTENCE OF AIR IN THE BONES OF BIRDS.

At a recent meeting of the Zoological Society, London, Dr. Crisp read a paper " On the Presence or Absence of Air in the Bones of Birds," for the purpose of showing the prevailing error upon the subject — namely, "that the bones of a bird are filled with air." Of fifty-two British birds recently dissected by him, only one, the sparrow-hawk (*F. nesus*), had the bones generally perforated for the admission of air. In thirteen others, the humeri only were hollow, and among these were several birds of short flight. In the remaining thirty-eight neither *humeri* nor *femora* contained air, although in this list were several birds of passage and of rapid flight.

RESPIRATION THE CAUSE OF CIRCULATION.

The above is the title of a theory recently proposed by Mrs. Emma Willard, the well known authoress, of Troy, N. Y., to account for the circulation of the blood, in opposition to the theory of Harvey, which maintains that the impulsive stroke of the heart's beat is the sole motive power. According to the views of Mrs. W. the cause of the circulation is to be found in respiration, that function bringing into the lungs, on the one hand, carbon mingled in the venous blood, as the fuel of the animal fire, — and on the other, oxygen, derived from the atmosphere, to consume it; these being in the lungs separated by a membrane, permeable by gases, though not by undecomposed fluid or air. Thus the carbon and the oxygen intermingling in the lungs, animal combustion ensues, and heat evolved; this passes into the

blood, which is about seven-eighths water. The lungs being in partial vacuo, and having a temperature at least thirty-five degrees above that required in a complete vacuum to change water into vapor, a portion of the water contained in the blood becomes steam. The volume of the blood thus enlarged exerts a specific force. The valves on the right side of the heart close against it, while those on the left open, to give it free passage. Thus, according to this theory, is generated the *primum mobile* — the true motive power, which first produces, and afterwards keeps up the circulation of the blood. In the mean time the mechanism of the heart not only determines by its valves the course of the blood current, but equalizes its flow, and adds, by the mechanical force of its stroke, to the chemical power. But without this power, however free the heart may be to act, as in drowning, hanging, etc., life can be but a few moments sustained.

This theory has received the support and sanction of some of the leading men in the medical profession of this country, and as such is worthy of a place in any record of the progress of science.

ACTION OF LIGHT ON MUSCULAR FIBRES.

At a meeting of the English Royal Society, during the past year, M. Brown Séquard presented a communication on the action of light on muscular fibres, independent of the influence of the nerves. That light is capable of producing such an effect, was mentioned by several of the old anatomists, but later authorities repudiated the idea, and the subject remained unnoticed. The experiments, however, of M. Séquard, prove that some portions of muscular fibre — the iris of the eye for example — are affected by light, independently of any reflex action of the nerves, thereby confirming former experiences. The effect is produced by the illuminating rays only — the chemical and heat-rays remain neutral. And not least remarkable is the fact, that the iris of an eel showed itself susceptible of the excitement sixteen days after the eyes were removed from the creature's head. So far as is yet known, this muscle is the only one on which light thus takes effect; and henceforth, the statement that "muscular fibre may be stimulated without the intervention of nerves," will have to be received among the truths of physiology.

ASTRONOMY AND METEOROLOGY.

NEW PLANETS DISCOVERED IN 1857.

The number of planetary bodies belonging to the solar system was increased during the year 1857, by the discovery of eight new asteroids. The forty-third asteroidal planet was discovered April 15, 1857, by Mr. Pogson, of the Radcliffe Observatory, Oxford, England. It appears as a star of the ninth magnitude, and has received the name *Ariadne.*

The forty-fourth was discovered by M. Goldschmidt of Paris, May 27. It appears as a star of the tenth or eleventh magnitude, and has received the name *Nysa.*

The forty-fifth was also discovered by M. Goldschmidt on the 28th of June, and has been called *Eugenia.*

The forty-sixth was discovered by Mr. Pogson of Oxford, England, on the 16th of August, and has received the name of *Pales.*

The forty-seventh was discovered by M. Luther, of the Observatory of Bilk, on the 15th of September, and has received the name of *Hestia.*

The forty-eighth and forty-ninth asteroids were discovered by M. Goldschmidt on the same evening, September 19th. The forty-eighth resembles a star of the eleventh magnitude, and the forty-ninth changes in brightness from the tenth to the eleventh magnitude. It has been suggested in the French Academy that these two asteroids should be termed the twins, and that to distinguish them, one should be named No. 1 and the other No. 2.

The fiftieth asteroid was discovered by Mr. Fergurson of the Observatory of Washington, on the evening of the 4th of October, and has received the name *Virginia.*

ON THE RINGS OF SATURN.

The theory of the gradual approximation of the rings towards Saturn, as advanced by several astronomical authorities, has been recently investigated by the Rev. Mr. Main of England, and Professors Kaiser and Secchi. Mr. Main, after submitting a series of observations of the rings to a searching investigation, came to the conclusion that there exist no real grounds for the hypothesis that the bright rings are gradually approaching the body of the planet. A similar result was deduced by Professor Kaiser. Professor Secchi's observations would seem to indicate that the rings, besides having a rotatory motion around the planet, are also elliptical.

BRORSEN'S COMET.

A comet discovered by Bruhn's of Berlin during the past year, has acquired an unusual interest, from the fact that its identity with a comet discovered by Brorsen of Kiel, has been satisfactorily proved, and its time of rotation about the sun determined. This amounts to a period of 2,026 days, (five years six and a half months) and the greatest axis of the line of rotation is about 600,000,000 miles long. — This is the third comet of short rotation known to us, the two others being those of Biela and Encke.

ON THE POSSIBLE EXISTENCE OF A LUNAR ATMOSPHERE.

The occultation of the planet Jupiter by the moon on the 2nd of January, 1857, afforded to English observers some results which have given rise no little speculation and theory.

An occultation of any of the larger planets is always an occurrence of surpassing interest to astronomers, because the clear, well-defined images which they present in good telescopes, are pictures of such exquisite delicacy, that they afford a very severe test of the condition of the lunar surface as to the presence or absence of gaseous or vaporous investment, when that surface is seen in front of the picture in the act of sweeping before it; the smallest amount of vapor or gas would perceptibly dim and distort the delicately sketched light image contemplated under such circumstances. When it is Jupiter that undergoes occultation, there is also additional interest, because this planet is waited upon by four satellites of considerable brilliancy, which have to pass in succession behind, and out from the border of the moon; so that there are, as it were, five occultations in one to be observed.

During the recent occultation of Jupiter, a large number of excellent observations were recorded. From among the trust-worthy observers, Messrs. W. R. Grove, Dawes, Hartnup, and J. Watson, Dr. Mann and Lord Wrottesly agreed in the positive statement that there was no perceptible alteration of the planet's figure, or distortion of outline, while the planetary image was in apparent contact with the moon, and under good optical definition. Mr. William Simms and Mr. Lassell, on the other hand, described the curved outline of the planet as appearing to be flattened, or bent outwards towards the moon's limb. Mr. Lassell's observation, however, affords a suggestion for the ready explanation of this discrepancy. This gentleman noted distortion as the planet went behind the moon, but distinctly states that there was none as it came out from concealment; and further remarks, that the *air was very unsettled*, and vision very unsteady at the commencement, but the definition much more even and satisfactory at the conclusion of the occultations. Mr. William Simms also says that the atmosphere at Carshalton, where his observation was made, was very unsteady. In all probability, the distortion of the planet's figure, noticed by these observers, was due to the *unfavorable state of the earth's own atmosphere* at their stations, causing the image of the planet to tremble and undulate while under inspection.

Mr. Hartnup and Dr. Mann noticed that the line-like segment of the planet's disc was broken up into three or four beads of light, just before it finally disappeared behind the moon. This result was due to small projections of the moon's border crossing the streak of light in some places, while portions of the streak were still visible at indentations of the lunar edge in others. Mr. Hartnup saw the third satellite of the planet *shining in the midst of a large indentation* of this kind for a second or two, and looking as if within the circumference of the lunar face. Professor Challis, employing the great Northumberland refractor at Cambridge, noticed that the moon's dark limb, as it swept in front of the bright planetary surface, was distinctly jagged and zigzagged by valleys and mountain-peaks.

As the planet slipped out from behind the *bright side* of the half-illumed six-day-old moon, the different characters of the planetary and lunar light were strikingly apparent. The planet's face was about as pale again as the moon's, and seemed to most of the observers watching it to wear, as compared with the moon's aspect, a soft greenish hue. Mr. Lassell was of opinion that the planetary faintness was mainly the result of the relatively large brilliant surface the moon presented in such close proximity; he believed that there would not have seemed anything like so marked a difference of intensity, if the planet had been contemplated in contact with a piece of the moon, having dimensions not larger than itself.

But the most interesting fact yet remains to be told. The bright border of the moon at this time crossed the soft green face of the planet, not with a clear, sharply cut outline like that which had been presented as the disc passed into concealment; it was fringed by a streak or band of graduated shadow, commencing at the moon's edge as a deep-black line, and being then stippled off outwardly until it dissolved away in the green light of the planet's face. This shade-band was about a tenth part of the planet's disc broad, and of equal breadth from end to end. Mr. Lassell described it as offering to his practised eye precisely the same appearance that the obscure ring of Saturn presents to a higher magnifying power, where that appendage crosses in front of the body of the Saturnian sphere.

There could be no mistake concerning the actual existence of this curious and unexpected apparition. It was independently noticed and described by at least six trustworthy observers, and the descriptions of it given by each of these corresponded with the minutest accuracy. The shadow was seen and described by Mr. Lassell, at Liverpool; by the Rev. Professor Challis, at the observatory at Cambridge; by the Rev. W. R. Dawes, at Wateringbury; by Dr. Mann and Captain Swingburne, R. N., at Ventnor; and by Mr. William Simms, at Carshalton. It therefore only needs that the unusual presence should be accounted for; the handwriting being there, the question remains to be answered; "Can its interpretation be found?" Can science read the meaning of this shadow-fringe inscription? Are there minds that can fathom, as well as eyes that could catch, this signal-hint thrown out by Jupiter at the instant of its emergence from its forced concealment behind the moon?

It was Mr. Dawes's impression on the instant, that the mysterious shadow

was simply an optical spectrum — a deep blue fringe to the light haze caused by the object-glass of his telescope having been accidentally over-corrected for one of the irregularities incident to chromatic refraction. This notion, of course, became altogether untenable so soon as it was known that the same appearance had been noted by other telescopes, in which the same incidental imperfection had no place. All felt that the shadow could not be referred to a regular atmospheric investment of the moon's solid sphere, because under such circumstances the streak should have been always seen when the rim of the moon rested in a similar way across a planetary disc. The sagacious Plumian professor of astronomy at Cambridge, Professor Challis, seems to have been the first to hit upon the true interpretation of the riddle. The indefatigable star-seer has long suspected that the broad dark patches of the lunar surface — the *seas* of the old selenographists — are really shallow basins filled by a sediment of vapor which has settled down into those depressions; in other words, he conceived that there are *fog-seas*, although there are no *water-seas*, in the moon. The general surface and higher projections of the lunar spheroid are altogether uncovered and bare; but vapors and mists have rolled down into the lower regions in sufficient quantity to fill up the basin-like hollows, exactly as water has gravitated into the beds of the terrestrial oceans. The professor, using the high powers of the magnificent telescope furnished to the Cambridge Observatory by the munificence of the late Duke of Northumberland, was able to satisfy himself that the planet actually did come out from behind a widely gaping hollow of the moon's surface — at the bottom of a lunar fog-sea, seen edgewise, so to speak. If a shallow basin extended for some distance round the curvature of the lunar spheroid, and if it were filled up with vapor, that vapor would rest at a fixed level, exactly after the manner of a collection of liquid, and such fixed level would be concentric with the general spheroidal curvature of the satellite. Under such an arrangement, there would therefore necessarily be a bulging protuberance of the vapor-surface, through which a remote luminary might be seen, when it rested in the requisite position. This, then, is Professor Challis's understanding of Jupiter's hint. The moon has fog-seas upon her surface, and the band of shadow visible upon the face of Jupiter as the planet came out from behind the earth's satellite, was a thin upper slice of one of those fog-seas seen by the favorable accident of the planet's light shining for the instant from beyond.

SPOTS ON THE SURFACE OF THE SUN.

The Royal Astronomical Society, G. B., have recently presented their medal to Mr. Heinrich Schwabe, of Dessau, Germany, for his researches, continued for a period of thirty years, on the spots which appear on the surface of the sun. From the address of the President, in presenting the medal, we derived the following information on this topic.

The plan adopted by Mr. Schwabe is, to note by a number each spot in the order of its appearance, carrying on his notation from the first to the last spot in each year. He reckons an isolated spot, or a cluster of spots where

there is no visible separation between their penumbræ, as one group. Hence, he observes, the number of spots will depend in a great measure on the excellence of the telescope; and it often happens that clusters of many hundred, nay of many thousand spots, will be designated by one number only, just as a single isolated spot will be. So great, however, is the sun's tendency to present his spots in the form of clusters, that other observers will, in the course of a year, assuredly not find any great difference between their numbers and mine. But he particularly impresses on his readers that he attaches importance not so much on the absolute number of the groups, as on the ratio which obtains between them in different years.

The result of his investigations has been to establish with a degree of probability almost amounting to certainty, that the solar spots pass through the phases of maximum and minimum frequency, and *vice versa,* in a period not very different from ten years.

The exact period Schwabe does not pretend to have determined. That it is liable to perturbation is evident. During twenty-seven years of the series the results were extremely regular; during the last three years they have shown symptoms of disturbance. The epoch of minimum, which, consistently with earlier indications, should have happened in 1853, did not occur until 1856.

Schwabe has not entered into speculations relative to the nature and origin of the spots, though he has been careful to note all remarkable appearances as they occurred; and of these he has given an admirable summary in the "Astronomische Nachrichten," number 473. There he calls attention to an appearance which, he says, is not uncommon, but which he cannot explain on the generally received theory, that the spots are portions of the surface of a solid body, seen through openings in a luminous atmosphere that surrounds it at a distance, and another intervening atmosphere. This theory of Sir W. Herschel has been found adequate to explain most of the phenomena of the spots. But the case to which Schwabe alludes is this. On the above hypothesis a spot surrounded by a penumbra, will, by the effect of perspective, when it first makes its appearance on the disc, seem to be excentrically situated on the penumbra, the border of the penumbra towards the sun's centre appearing less broad than the other border. All this is intelligible, but why is not the penumbra equally illuminated all round? For it frequently happens that the border turned towards the sun's centre is dark gray, while that towards the sun's limb is bright gray, and between the latter and the nucleus there is a string of light almost as bright as the sun's disc.

He also mentions having seen, though rarely, the phenomenon which furnished Francis Wollaston and Lalande with an argument against Alexander Wilson, who was the first to advance the theory of the spots being cavities. The phenomenon is this: — Sometimes a spot surrounded by a penumbra passes over the sun's disc without the former undergoing any change of relative position, from the beginning to the end of its course. This apparently militates against the cavity theory. Arago says the objection is not insurmountable. "Suppose," says he, "in such cases, that the sides of the

openings in the photosphere, through which the spot appears, are not sloping." But according to Wilson's theory the penumbra is formed by the sloping sides of the photosphere — and there is the penumbra. Therefore it appears that this explanation does not hold good on Wilson's view. According to Sir W. Herschel another stratum is interposed between the solid body of the sun and the photosphere. On this hypothesis, it is the part we see of the secondary stratum which constitutes the penumbra; if, therefore, it be sensibly depressed below the surface of the photosphere a change of relative position must ensue. Schwabe's explanation is, that when the phenomena in question occur, the secondary stratum has risen to an unusual height, and is not sensibly depressed below the photosphere.

The address of the President of the Society concludes as follows: —

"You are aware, gentlemen, it has been long known that the intensity of magnetic declination is subject to a daily variation; and this variation was also known to be in some way connected with the sun, attaining its maximum western limit when that body is at its upper and lower culmination, and its maximum eastern limit about six o'clock in the morning an evening. These are not the exact times, but they are sufficiently near for our purpose. About the year 1850, Professor Lamont announced that this variation was again liable to another variation, which observed a period, from maximum to minimum, and from minimum to maximum, of about ten years. He was led to this result by a discussion of his own observations at Munich. It was shortly after fully confirmed by our colleague, General Sabine, by the observations made at the Magnetic Observatories of Toronto and Hobarton. But in the course of the latter discussions General Sabine detected another important circumstance which had escaped Lamont, viz., that the periods of maximum variation of the declination-needle correspond exactly with those of the maximum frequency of the solar spots, and *vice versa*, the minimum of the one with the minimum of the other. Hardly had General Sabine's paper been read before the Royal Society, on March 18, 1852, when intelligence was received that two Swiss physicists, Professor Gautier of Geneva, and Professor Wolf of Berne, had arrived at the same conclusion, independently of each other, from a perusal of Lamont's results.

"All the observations I have mentioned were made during nearly the same time — between the years 1840 and 1851 — comprehending only a single period of change. Obviously, therefore, in this state of the inquiry it was of the highest importance to obtain a trustworthy series made at another time and under different circumstances. Though hardly to be expected, it happened, most fortunately, that such a series was at hand.

"The diurnal variation was one of those subjects which, many years ago, had particularly interested the vigorous mind of the lamented Arago; and among his papers were found the records of a most laborious course of experiments, conducted with all the care which no one knew better than he how to bestow on a delicate investigation. These experiments, extending from 1820 to 1831, have been rigorously discussed by M. Thoman, and exhibit the prevalence of the same law that obtains in the later series.

"Nor does the evidence of connection rest here. In a recent paper sent to

the Royal Society, General Sabine has shown that at Toronto (the only series hitherto fully discussed) all the magnetic elements subjected to observation undergo similar variations. In the face of these coincidences, to doubt the relationship between the two phenomena seems to me to be almost as unreasonable as to doubt the influence of the moon on the tides of the ocean.

"For thirty years never has the sun exhibited his disc above the horizon of Dessau without being confronted by Schwabe's imperturbable telescope, and that appears to have happened on an average about 300 days a year. So, supposing that he observed but once a day, he has made 9000 observations, in the course of which he discovered about 4700 groups. This is, I believe, an instance of devoted persistence (if the word were not equivocal, I should say, pertinacity) unsurpassed in the annals of astronomy. The energy of one man has revealed a phenomenon that had eluded even the suspicion of astronomers for 200 years."

PERIODICAL METEORS.

The periodical meteors of August, 1857, were studied by the orders of M. Le Verrier, the Astronomer Royal of France, from Paris and Orleans, by simultaneous observations, to ascertain their actual distance from the earth, by calculating the angles at which they appeared to the two observers. But out of about sixty seen, Mr. Liais, who discussed the results, could be certain of only six being the same stars seen by both. These six stars, at the moment of appearing and disappearing, were calculated to be distant from the earth as follows:

No. 1,	35,000 —— 11,000	metres,	equal to	23.7	miles
No. 2,	33,000 —— 25,000	"	"	24.17	"
No. 3,	31,000 —— 21,000	"	"	20.14	"
No. 4,	37.000 —— 25,000	"	"	25.3	"
No, 5,	83,000 —— 13,000	"	"	55.9	"
No. 6,	119,000 —— 66,000	"	"	79.44	"

and their rapidity, as 14, 14, 16, 17, 55, and 75 miles per second, which affords the curious coincidence (for in the very imperfect state of our knowledge about these mysterious visitants this fact is little more), that the highest were the swiftest.

In 1839, De Vico at Rome, and Nobile at Naples, made simultaneous observations of this sort in the nights of the 23d, 24th, 25th, and 31st of August, and saw the same meteor thirty-one times, and so exact were the results that they served as well as the best ordinary methods for correcting the difference of longitude of those places forty-three leagues apart, while Paris is only twenty-eight leagues from Orleans.

DISCOVERY OF DOUBLE STARS.

Some very interesting discoveries of double stars have recently been made by Mr. Alvan Clark, of Boston, the well known telescope manufacturer, who

has adopted the plan of testing the efficiency of his object-glasses when completed, by sweeping for new double stars of the last degree of difficulty, rather than by the examination of objects whose character was previously known. At first, under the impression that every such object in the northern hemisphere visible with telescopes of moderate aperture must already have been picked up and registered during the careful examinations of that portion of the heavens by the Struves with the Dorpat refractor of 9·6 inches aperture, and with the Poulkova of fifteen, Mr. Clark confined his search to the southern hemisphere; and his diligence and skill were rewarded by the discovery of several interesting objects, which, it might be supposed, would hardly have escaped the Dorpat telescope if they had been as decidedly double in 1826 as they are now. Latterly, however, having ventured to extend his researches northward, he has made some discoveries which are almost startling (especially the duplicity of the very minute companion of μ Herculis), and are sufficient to show that there is much which may be achieved by a diligent use of instruments of moderate dimensions, provided they are also of extreme perfection.

ON A LAW OF TEMPERATURE DEPENDING UPON LUNAR INFLUENCE.

In a paper on the above subject, read before the Dublin meeting of the British Association, by Mr. J. P. Harrison, the author commenced by saying that, although the question of lunar influence on the atmosphere of our planet was very generally considered as set at rest by the investigations of M. Arago, yet he felt very confident that he was in a position to prove the law he was now about to announce without fear of contradiction. He had reduced and thrown into the form of tables and of curves 280 lunations, with the corresponding mean temperatures; and the laws at which he had arrived were; first, between the first and second octant the temperature immediately after the first quarter, both on the average and also, with rare exceptions, in each individual lunation is higher than the temperature shortly before the first quarter; secondly, and more particularly the mean temperature of the annual means of the second day after the first quarter (or the tenth day of the moon's age) is always higher than that of the third day before the first quarter (or the fifth day of the lunation).

Mr. Fulbrook, of Sussex, England, in a recent communication to the London Athenæum, calls attention to the result of his investigations of the moon's position with reference to the plane of the earth's orbit, considered in connection with the rain fall. He says, "I am induced to do this, because I think it is extremely desirable that meteorological observers of other latitudes should investigate this important subject. Should any do so, I shall feel greatly obliged by being informed of the result. The moon occupies about twenty-seven days in passing from any point — say her ascending node — round the zodiac to the same again. During one half of this time she is in north (celestial) latitude, the other half in south latitude. I took one hundred such lunar courses in due order. The fall of rain during

five days in each of the one hundred courses — five hundred days about, or near, the time the moon was ascending through the plane of the earth's orbit — amounted to 47·60 inches, while the same number of days in the opposite part of her course, i. e., when she was descending through the plane, only gave 26·42 inches. The wettest point just preceded the ascent of the moon, and the driest the descent of that luminary through the plane of the earth's orbit. Whatever may be the more immediate cause of the above mentioned difference — whether the ascent of the moon, through the plane, towards the Northern Pole produces aerial currents from south to north, or whether it diminishes the atmospheric pressure, and thus promotes evaporation and an excess of rain — it is reasonable to infer that when she is thus, in some way, producing such excess in this hemisphere, comparatively dry weather obtains in the southern hemisphere, and *vice versa*, and that intermediate latitudes experience intermediate effects."

GALES OF THE ATLANTIC.

During the past year Lieut. M. F. Maury, the director of the National Observatory, has published a series of charts of the North and South Atlantic, exhibiting by means of colors the prevalence of gales over the more stormy parts of the oceans, for each month in the year. One color shows the region in which there is a gale every six days, another color every six to ten days, another every ten to fourteen days, and there is a separate chart for each month and each ocean. The author observes that this is the first attempt to delineate the rain regions over these oceans, and that although the result has cost much labor, it is necessarily imperfect in consequence of the few observations as data on which he has had to rely. It is an initial step in an important work.

ON THE ZODIACAL LIGHT.

At the Montreal meeting of the A. A. A. S. Capt. Wilkes, U. S. N., presented a paper on the Zodiacal Light, of which the following is an abstract:

In the outset he stated that the suggestions he had to present were the result of numerous observations taken during the prosecution of the United States Exploring Expedition to the South Seas, several years ago, and that the conclusions to which he had arrived then were abundantly confirmed by more recent observation.

All the observations of the zodiacal light showed that it had not changed its appearance since two centuries ago, when first noticed by Cassini; and by observing it particularly, with reference to the great circles of the globe — ecliptic and equinoctial — it becomes manifest that all changes of its appearance depends solely on the position of the spectator on the surface of the globe. The theories which have been entertained of this light are various. Some derive it from the atmosphere of the sun — holding that it is illuminated matter thrown off from his equator, revolving with immense velocity, which takes a particular shape. Others have held that it is a nebulous ring,

with the sun for its centre, extending near to or beyond the earth's orbit. Another hypothesis supposes that this nebulous ring has the earth for its centre; and still others surmise that this phenomena is nebulous matter floating in space, to which the periodical showers of stars may be traced, as the earth happens in its orbit to pass through or encounter them. It seems impossible to reconcile any of these hypotheses or surmises with the facts which close observation has developed. They fail to satisfy us of their correctness, as they are soon perceived to be inconsistent with well ascertained facts.

The zodiacal light, when first visible on a clear horizon, appears as a semicircular arc, with six or ten degrees base, well designed and distinct to the eye, though no two persons could trace the same outline of it. As darkness progresses, this semi-circular arc elongates upwards, in successive altitudes, sometimes to the altitude of sixty degrees. When it has attained its highest point, the diffused light becomes visible, extending on each side over a large area, until lost in the obscurity of night. It is totally different from the extended light of sunset, with crepuscular rays, or the diffused light of twilight. When it becomes visible, it continues so, gradually lessening in height, until the whole is lost beneath the horizon. Its apex is always observed in the ecliptic, to the east or west of the sun, usually at the distance of sixty to eighty degrees, but at times, under favorable circumstances, it is seen to extend as far as 110 degrees.

The evening and morning zodiacal light in the same latitude do not correspond in phase or azimutn. This, though among the remarkable facts it exhibits, has never been taken into consideration in any of the theories hitherto advanced. Its peculiar phase and the constant change of azimuth and inclination, whether the observer remains stationary for any time or varies his position in latitude, should satisfy every one that it cannot be far removed from the earth. Attentive and close observation shows that its variations in azimuth correspond to the regular changes of the plane of the ecliptic with the observer's horizon or with the vertical line passing through his zenith. Its phases will be seen to be dependent upon the latitude. The vividness of the light and its extent are in like manner to be ascribed to the observer's position on the earth. Within the tropics, and when the ecliptic is perpendicular to the horizon, the zodiacal light is confined to a slender column having its diffused light widely extended. Without the tropics it is always seen very much inclined to the horizon. It then assumes the appearance of a cone, cut more or less obliquely by the horizon. In northern latitudes the light had a greater altitude than in more southern ones; but owing to the long twilights, was little visible, though it might be observed in the vernal and autumnal equinoxes even in this latitude. The light in the morning was not of the same color as in the evening; in the first case being grayish, in the other having a reddish blush, depending on the approach or retreat of the sun. After sunrise, he had seen it reach the zenith, with a breadth of only two and a half degrees. Sometimes the phenomenon was very beautiful, as if a gauze veil were spread over the atmosphere, through which the stars could be readily, though dimly seen. Thus the light stood alone and distinct from all others; its central line being parallel to the eclip-

tic, usually a little to the north or south of it, but sometimes corresponding with it.

The facts observed by him from observation, condensed, are as follows:

1. The zodiacal light occupies a constant relative position in the plane of the ecliptic, preceding or following the sun.

2. Its central line is parallel with and coincides with the ecliptic.

3. Its apex varies in distance sixty to one hundred and ten degrees from the sun. Its height above the horizon seldom exceeds sixty degrees.

4. Its azimuth changes with the sun, and with the observer's position on the earth.

5. Its inclination alters with the position of the observer in latitude, from the vertical down to an acute angle with the horizon.

6. The morning and evening zodiacal light are different in phase, color, altitude, and inclination, depending upon the angle subtended between the observer's horizon and the plane of the ecliptic.

7. Its apex lies always south of the zenith when the observer is north of the ecliptic, and north of the zenith when he is to the south of the ecliptic.

8. When the ecliptic passes through the zenith of the observer, the column of light is vertical to the horizon; it then assumes the appearance of a narrow belt, with a well defined apex.

9. North or south of the ecliptic, the zodiacal light exhibits a broader phase, but less in altitude than when under it.

10. The zodiacal light is never seen until the sun has set and twilight ended, or until all reflected light is cut off; therefore, visibility depends upon the continuance of twilight.

11. Owing to the length of twilight, the zodiacal light is seldom ever near the limiting parallel. The limiting parallels vary with the sun's declination.

12. The sun's rays falling perpendicularly on the atmosphere within the tropics, are not reflected; consequently after sunset there is little or no twilight.

These facts go to prove that this phenomenon is the result of the illumination of that portion or section of the earth's atmosphere on which the rays of the sun fall perpendicularly. It will readily be conceived that rays of light will illuminate a column or portion of atmosphere on which they may fall, when no reflected or diffusive light interferes to prevent its being visible. To illustrate: if the direct rays of the sun are admitted through a hole in a shutter into a darkened room, the atmosphere and the particles floating in it become as visible and distinct when all reflected light is cut off as any well defined object. It is this which we believe takes place when the rays of the sun fall perpendicularly on our atmosphere, and produce such an effect which becomes visible upon the earth's surface when this column is above the horizon, within the limiting parallels, and after the twilight has ceased. The whole earth is constantly exposed to and revolves in the sun's rays. A part of these rays only fall perpendicularly on our atmosphere, while all others strike it obliquely, are reflected and refracted by it. As the earth revolves, this column or section of the atmosphere which lies in the ecliptic or earth's orbit becomes illuminated in succession, and thus appears permanently at-

tendant on the sun. It is this section or cone which is visible when all reflected light is cut off, and has been named the Zoidiacal Light. This theory seems to account for all the phenomena which the zodiacal light exhibits.

As the column or cone of illuminated atmosphere has apparently a visible extent in the heavens, along a parallel with the ecliptic, both preceding and following the sun, it has produced the delusion that it belongs to or is connected with the heavens. A moment's reflection satisfies us that this phenomenon as seen projected in the heavens with the starry host twinkling through it may produce the same effect, and we are only able to overcome this ocular deception by proving, as we have done by attentive observation, that it is of this earth, or closely connected with it, from its constantly undergoing great changes in azimuth, phase, inclination and altitude, as well to a stationary observer as to one who is passing over the earth's surface from north to south, and *vice versa.* If it were distant or of heavenly origin, this would not be the case, as these rapid changes could not then take place. Therefore we are compelled to admit that we are deceived, and that its locality must be in the atmosphere surrounding this globe, and be an illuminated section of it which becomes visible as soon as twilight ceases and darkness ensues. That it lies between us and the milky way is evident — for when bright it nearly eclipses that starry nebulæ. This theory is in strict accordance with all the observations yet made.

Now it may be understood how all bodies giving sufficient light to illuminate the atmosphere by perpendicular rays may produce an effect similar to the zodiacal light, though in a much less degree. A corresponding appearance has been seen to accompany the moon and the larger planets, and to this cause Capt. Wilkes attributes the phenomena noticed by the observer of the Japan Expedition, leading him to suppose that they were produced by the morning and evening zodiacal lights visible at the same moment.

At the same meeting another paper, on the Zodiacal Light, was presented by Rev. George Jones, U. S. N., the author of the theory which supposes the phenomena in question to be occasioned by a ring of luminous matter encircling the earth.

Mr. J. stated, that after the publication of his Japan Observations, he felt the want of still further data, and determined to go to Quito, Ecuador, as the most eligible spot for this purpose. The advantages of this place are that it is near the equator, is freer from clouds than lower altitudes in equatorial latitudes usually are, and the transparency of the atmosphere at so great an elevation — so valuable in celestial observations. He was here enabled to see the zodiacal light not only at the horizon, but forming a complete arc across the sky, reaching quite from the eastern to the western horizon, and this at every hour of the night. It was sometimes so bright as to resemble another milky way stretched across the heavens. He brought back with him 115 drawings exhibiting the luminous arch, giving its boundaries as seen among the stars, and also the centre line — the brightness at the central part being always decidedly greatest — thence diminishing towards the edges. The deductions drawn by Mr. J. from these observations are as follows: —

First — The substance giving the zodiacal light formed a complete circle round the earth, as at all the observations which had been taken it was found that the light extended completely across the sky from east to west; and from the observations having been taken at regular intervals during the night, the arch was observed at different angles to within eighteen degrees of a complete circle.

Second — It was a great circle, forming an angle of three deg. twenty min. with the ecliptic, the ascending node being at longitude sixty-two deg., and descending node at longitude two hundred and forty-two deg. The width appeared to vary at different times, seeming to be greatest at the latest observations, which he attributed to his sight having become more accustomed to the light. He came, however, to the conclusion that the average width as seen with the eye is twenty-eight degrees, which, at say 100,000 miles, would give a nebulous circle of enormous extent.

Third — It is a geocentric circle. If it were heliocentric, then the portions in the direction of the sun would have to be 170 or 190 millions of miles from the spectator, and the opposite side comparatively near to him, consequently this ring, by the rules of perspective, would be made at the nearest part, and greatly narrowed near the sun, where it would terminate almost in a point.

The facts are not so, for the ring has the same width in its whole extent. Again, if heliocentric, the laws of optics for reflected light would require the portion nearest to a line with the sun to give less reflected light than towards the spectator's zenith; but the fact is that the light nearest the horizon is always much brighter than it is higher up. Again, the brightest portion of the zodiacal light showed an affinity to the spectator's motion as his zenith approached or receded from the ring, which can belong only to an object not very far off.

ON THE DISTRIBUTION OF THE ORBITS OF COMETS.

The following is a *resumé* of a paper read before the British Association at is last meeting, by Prof. M. Mosetti, on the above subject: —

The author commenced by explaining that the simplest and most direct method of analyzing the distribution of the comets in space would seem to be, to divide the celestial sphere by means of circles parallel to the ecliptic into equal zones corresponding to an aliquot part of the entire superficies, and then to ascertain how many culminating points are contained in each of these. If the orbits were uniformly distributed throughout space, each of them should contain about an equal number of these points; if not, the greater or less number contained in each will serve to show the tendency the orbits have to approach to or recede from that distribution. The author applied this method arithmetically in the first instance; and afterwards, in order to render the results more palpable, reduced them to a graphic construction. He thus found the orbits to have a tendency to approach in prevailing numbers the polar regions of the ecliptic. The minimum occurs in the fifth zone of each hemisphere. Those whose parhelia are in the Northern hemis-

phere exceed those whose parhelia are in the southern in the proportion of three to two, five to six, or nearly equal. The author calls the Great Circle, which passes so as to divide the Milky Way pretty equally, the Galaxy Circle. In the centre of this the Sun and Earth may be considered to be placed; it cuts the ecliptic towards the solstitial points, and is inclined to it at about sixty deg. He then finds that the planes of the orbits of the comets are, for the most part, little, if at all, inclined to the plane of the Galaxy Circle, and that they go on decreasing in number as that inclination increases; and, therefore, he concludes that some cosmical cause must have led to such a result. Also, the parhelia of by far the greatest number of those he has discussed are found near the Galaxy Circle, showing that when they are passing most closely under the influence of the Sun they are both near the Galaxy Circle, and their proper motion is nearly parallel to its plane. Hence the greater number of comets come to us from the region of the Galaxy itself.

THE DIVISION OF BIELA'S COMET.

BY D. VAUGHAN.

The forces which occasionally disturb the tranquillity of our atmosphere, must have a wide field for their operation in the vast expanse of aeriform matter, which constitutes the principal part of cometary bodies. Like all light bodies, the air we breathe is very sensitive to electrical attraction and repulsion; and this becomes a frequent cause of storm. Wherever the prevalence of moisture makes the superfluous electricity descend from the region of the clouds to the ground, the air is repelled, and forms an ascending current. As it undergoes expansion during the ascent, the cold which this occasions condenses the accompanying vapor; so that descending drops of rain diffuse moisture through the medium which they traverse, and thus improve its conducting power. Accordingly, the discharges of electricity are constantly repeated, and the aerial current continues to ascend, while the surrounding air presses on to the scene of action, and participates in the great movement. Such is Dr. Hare's theory of storms; but some part must be ascribed to the heat evolved by the condensation of the watery vapor.

If the small quantity of dense matter which is required to hold together the rare cometary gases, contained a large proportion of water or some other volatile substance, much vapor should be generated on the approach of the comet near the sun. Whenever this vapor condensed, at the place screened from the solar rays or in any other locality, a discharge of electricity would occur between the envelop and the central mass of the comet, while ascending currents of air commenced in the rare fluid, and determined the focus of a storm. Owing to its vast height, the greater part of the nebulous appendage would participate in the movement, and give it a degree of impetuosity which the feeble attractive power of the nucleus could scarcely control. If ascending currents of air on our own planet prevent condensed vapor from falling until it forms large drops of rain, hailstones of considerable size, and in some cases, waterspouts; the vapor returning to a liquid state in the atmosphere of a comet, where gravity is many thousand times more feeble, might be sustained by similar ascending currents, until it had collected into

bodies as large as lakes or seas. Even large collections of the fluid evaporated from the central nucleus, may be sometimes driven in this manner beyond the sphere of the comet's effective attraction; and may separate for ever from the primitive mass, taking away by its attraction much of the attenuated matter composing the envelop.

That the division of Biela's comet arose from a cause of this nature is proved by a remarkable fact. The two parts into which this body divided were almost equal in size and brilliancy, when nearest to the sun; but at a more considerable distance from him, one was about eight times as large as the other, and about four times as bright. This shows that they differed much in their capabilities of affording material for evaporation; and it is precisely what should occur if one were fluid and the other composed almost exclusively of solid matter. On approaching the sun, the nebulous appendage of the first should swell by the introduction of vapor, while the small amount of vapor contained in the other would be only rendered invisible by solar heat. Other comets manifest signs of similar commotions; and we cannot fail to recognize the close relation between the agencies operating on our own globe and on the more humble members of the solar family.

ON THE GRAND CURRENTS OF ATMOSPHERIC CIRCULATION.

The following is an abstract of a new theory of atmospheric circulation brought before the British Association, at Dublin, by Mr. J. Thomson: —

It has been ascertained as a matter of observation, that in latitudes extending from about thirty degrees to the poles, the winds, while prevailing from west to east, prevail also in directions from the equator towards the poles. Now this motion towards the poles appears not to have been hitherto satisfactorily explained. In fact it is the contrary motion to what is naturally to be expected when the theory of Halley, which was given about the year 1686, and which appears to afford the true key to the explanation of the trade winds, is followed up with respect to the circulation of the air in other latitudes than those in which the trade winds occur. According to this theory so applied, it would naturally be expected that the air, having risen to the upper regions of the atmosphere in a hot zone at the equator, should float towards the north and south polar regions in two grand upper currents, retaining, as they pass to higher latitudes, some remains, not abstracted by friction and admixture with the currents below, of the rapid equatorial motion of about 1,000 miles per hour from west to east, which they had in moving with the earth's surface at the equator. Also, it would be expected that the air in the polar regions should have a prevailing tendency to sink towards the surface of the earth, in consequence of its increased density caused by cold; and that it should tend to flow from the polar regions along the surface of the earth, towards the equator, with a prevailing motion from west to east in advance of the earth, until, by friction and impulses on the earth's surface, the motion in advance of the earth is retarded and counteracted. The theory, however, thus deduced, is found in one essential point to be controverted by observations. This point is what was stated in the outset of the present arti-

cle, namely, that the prevailing winds on the surface of the earth in latitudes higher than thirty degrees, are, while blowing from the west, as should be expected, found to blow more towards the poles than from the poles; and thus do not move as if impelled along the surface of the earth from polar to equatorial regions by an augmented pressure due to condensation by cold in polar regions, and a diminished pressure due to rarefaction in the equatorial regions. Observations being thus at variance with the only obvious theory proposed, the circumstance in question has been commonly regarded as rather paradoxical; and Lieut. Maury found himself forced into supposing an entire reversal in latitudes above thirty degrees of the great circulation just described. Mr. Thomson regards Lieut. Maury's supposition as being entirely unsupported by the known physical causes of the atmospheric motions. He, on the contrary, maintains that the great circulation already described does actually occur, but occurs subject to this modification, that a thin stratum of air on the surface of the earth in the latitudes higher than thirty degrees — a stratum in which the inhabitants of those latitudes have their existence, and of which the movements constitute the observed winds of those latitudes — being, by friction and impulses on the surface of the earth, retarded with reference to the rapid whirl or vortex motion from west to east of the great mass of air above it, tends to flow towards the pole, and actually does so flow, to supply the partial void in the central parts of that vortex, due to the centrifugal force of its revolution. Thus it appears that, in temperate latitudes, there are three currents at different heights; —that the uppermost moves towards the pole, and is part of a grand primary circulation between equatorial and polar regions; — that the lowermost moves also towards the pole, but is only a thin stratum forming a part of a secondary circulation; — that the middle current moves from the pole, and constitutes the return current for both the preceding; — and that all these three currents have a prevailing motion from west to east in advance of the earth. This is the substance of Mr. Thomson's theory; and he gives, as an illustration, the following simple experiment: — If a shallow circular vessel, with flat bottom, be filled to a moderate depth with water, and if a few small objects, very little heavier than water, and suitable for indicating to the eye the motions of the water in the bottom, be put in, and if the water be set to revolve by being stirred round, then, on the process of stirring being terminated, and the water being left to itself, the small particles in the bottom will be seen to collect in the centre. They are evidently carried there by a current determined towards the centre along the bottom, in consequence of the centrifugal force of the lowest stratum of the water being diminished in reference to a strata above through a diminution of velocity of rotation in the lowest stratum by friction on the bottom. The particles being heavier than the water, must, in respect of their density, have more centrifugal force than the water immediately in contact with them; and must, therefore, in this respect have a tendency to fly outwards from the centre, but the flow of water towards the centre overcomes this tendency and carries them inwards; and thus is the flow of water towards the centre in the stratum in contact with the bottom palpably manifested.

OBITUARY

OF PERSONS EMINENT IN SCIENCE. 1857.

Anderson, M., an explorer, killed in Southern Africa.
Archer, J. Scott, inventor of the collodion process.
Bailey, Prof. J. W., the eminent microscopist.
Ball, Dr. Robert, an eminent Irish naturalist.
Beaufort, Admiral, R. N., Hydrographer to the English Navy.
Biela, M., the well-known astronomer.
Bonaparte, Charles, Prince of Cannio, distinguished as an ornathologist.
Bremmar, James, the English engineer who got off the Steamer Great Britain from the rocks of Dundrum Bay.
Britton, John, an English writer on architecture.
Brunnhoff, Prof. Govanni de, an Italian naturalist.
Caley, Sir George, a prominent English writer on science.
Carstenstein, Geo., Architect of the N. Y. Crystal Palace.
Cauchy, Augustin, a distinguished French mathematician.
Colla, M., director of the observatory at Parma.
Conybeare, Rev. W. D., the well-known English geologist.
Couper, Dr. William, Prof. Nat. Hist. University of Glasgow.
Dick, Rev. Thomas, well known from his astronomical writings.
Dufrenoy, A. the distinguished French mineralogist, and Chief of the School of Mines.
Dumont, M. A., a Belgian geologist.
Flemming, Prof., a Scotch naturalist.
Gedney, Com. U. S. N., an eminent American hydrographer.
Gliddon, George R., Author of "Types of Mankind," etc.
Gravenhorst, Dr., an eminent German geologist.
Graves, Capt. R. N., a distinguished English hydrographer.
Gray, Hon. F. C., a prominent member of the American Academy.
Hall, Dr. Marshall, the distinguished physiologist.
Herndon, Lieut. U. S. N., the explorer of the Amazon. Lost at sea.
Hincks, Dr., an Irish naturalist.
Harris, Rev. Dr., author of the "Pre-Adamite Earth," etc.
Jahn, Dr., a celebrated Prussian mathematician.
Kane, Dr. Elisha K., the Arctic explorer.
Knapp, Dr., author of "British Grasses."
Lichtenstein, Dr., Prof. of Nat. Hist. University of Berlin.
Manny, John H., inventor of "Manny's Reaper."
Meyer, Prof. Antoine, an eminent mathematician, of Belgium.
Mitchell, Prof. Elisha, of North Carolina.
Murray, Robert, an English chemist.

Pascerini, Prof., an eminent Italian geologist.
Redfield, W. C., the distinguished American meteorologist.
Rendell, Jas. M., F. R. S., a distinguished English engineer.
Rion, M., a Swiss naturalist.
Savauge, M. F., an eminent French engineer, the claimant of the invention of submerged propellers.
Scoresby, Dr. William, F. R. S., an eminent English physicist.
Spinola, Marquise, an Italian naturalist.
Strain, Lieut. U. S. N., a distinguished explorer.
Taupenot, M., inventor of the collodio-albumen process.
Thenard, Baron, the distinguished French chemist.
Tuomey, Prof. Michael, an eminent American geologist.
Ure, Andrew, Dr., an English chemist, author of "Ure's Encyclopedia."
Vogel, Dr., the African explorer; murdered in Central Africa.
Young, Hon. Augustus, State Naturalist of Vermont, etc.
Wossowolschski, M., a naturalist of Moscow.
Wyeth, N. J., inventor of the ice-machinery.

LIST OF BOOKS, PAMPHLETS, ETC.,

ON MATTERS PERTAINING TO SCIENCE, PUBLISHED IN THE UNITED STATES DURING THE YEAR 1857.

Agassiz, Louis. Contributions to the Natural History of the United States. Vols. I. and II. Boston: Little & Brown.

Alchemy and the Alchemists. 12mo. Crosby and Nichols, Boston.

American Almanac for 1858. Crosby & Nichols, Boston.

American Association for the Advancement of Science. Proceedings for 1856, 10th meeting, pp. 260.

American Encyclopedia. Vol. First. Ripley and Dana, Editors. Appleton & Co., N. Y.

Annals of the Astronomical Observatory of Harvard College. Vol. II, Part 1. 136 pp. 4to, with numerous plates. Cambridge, 1857.

Bell, John, M. D. The Mineral and Thermal Springs of the United States and Canada. 12mo. Parry & McMillan, Philadelphia.

Bache, Prof. A. D. Coast Survey Report for 1856. Pub. Doc.

Blake, W. P. Observations on the Physical Geography and Geology of the Coast of California from Bodega Bay to San Diego.

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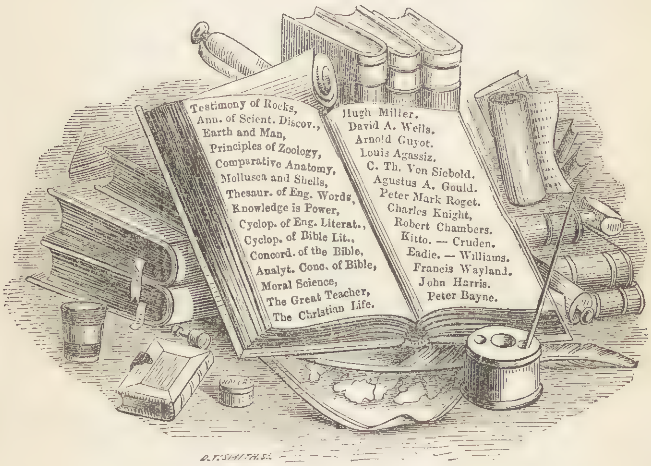

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